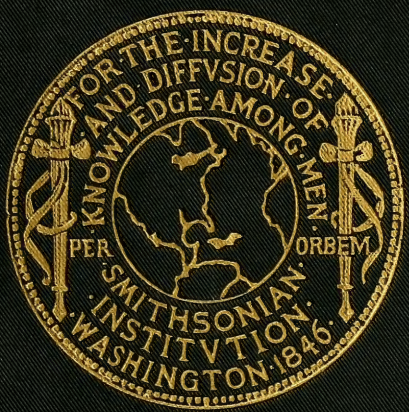
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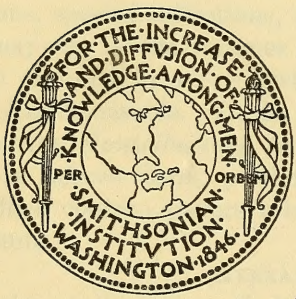

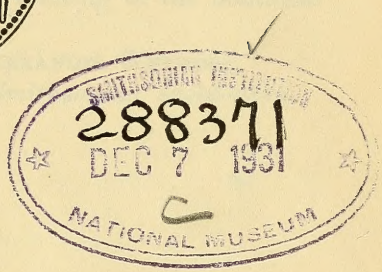

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ALEXANDER WETMORE,
Assistant Secretary, Smithsonian Institution.

WASHINGTON, D. C., *May 5, 1931.*

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By Emmett W. Price

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By Clarence R. Shoemaker

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TWO NEW SPECIES OF TREMATODE WORMS OF THE GENUS EUCOTYLE FROM NORTH AMERICAN BIRDS

By Emmett W. Price

Of the Zoological Division, Bureau of Animal Industry, United States Department of Agriculture

In this paper two species of trematodes which appear to be new are described. These forms belong to the family Eucotylidae Skrjabin, 1924, and to the genus *Eucotyle* Cohn, 1904. The first of these was collected in 1897 from the intestine of *Colymbus auritus* by Dr. A. Hassall, at Washington, D. C. For this species the name *Eucotyle hassalli* is proposed. The second species was found mixed with some specimens of echinostomes which were collected from the intestine of a blue-winged teal, killed at Lake Garberson, Miles City, Mont., by Everett E. Wehr, of the Zoological Division, May 20, 1929. For this species the name *Eucotyle wehri* is proposed.

Despite the fact that these trematodes were recorded as from the intestine by the collectors, it is quite improbable that the intestine is their normal location, since all members of the genus are parasites of the urinary tract. It appears reasonable to assume, therefore, that during evisceration they escaped from their normal location in the urinary tract and adhered to the outside of the intestine, and were later found in the washings from the intestines.

The genus *Eucotyle* was proposed by Cohn (1904) for a trematode which was named *Monostomum nephriticum* by Mehlis (in Creplin, 1849). Skrjabin (1920) described a species, *Eucotyle zakharowi*, from the renal tubules of *Fuligula cristata* in Russia, and later (Skrjabin, 1924) he described an additional species, *E. cohni*, from the kidney tubules of *Podiceps nigricollis* and *P. griseigena*, collected in Russian Turkestan. The characters of the genus as emended by Skrjabin are as follows:

Genus EUCOTYLE Cohn, 1904

Generic diagnosis.—Elongated, flattened, medium-sized monostomes; anterior end triangular and set off from the remainder of body by a dorsal and ventral transverse muscular ridge, posterior

end rounded. Testes opposite each other, either entirely extracecal, partly overlying the ceca, or occupying the entire width of body and with their median borders touching. Ovary lobate, pretesticular, and to the side of the median line. Vitellaria extracecal, commencing immediately posterior of the transverse muscular ridge and extending backward as far as the testes or beyond. Parasites in the kidneys of water birds.

Type species.—Eucotyle nephritica (Mehlis, 1846) Cohn, 1904.

EUCOTYLE HASSALLI, new species

Specific diagnosis.—Eucotyle: Body elongate, 2.5 mm. long by 620μ to 650μ wide; anterior end triangular and set off from the remainder of body by a transverse ridge situated 400μ to 434μ from the anterior end. Cuticle evidently uniformly covered with spines but in the specimens available for study only a few scattering blunt

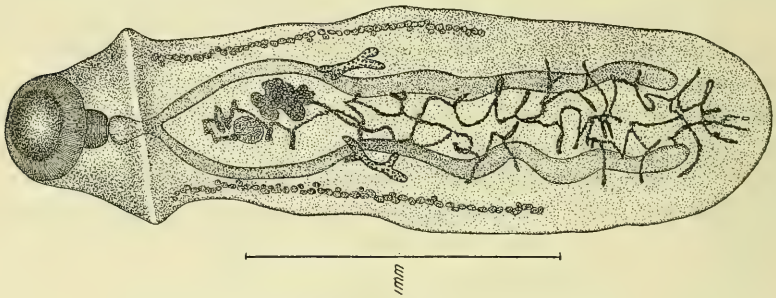

FIGURE 1.—EUCOTYLE HASSALLI. VENTRAL VIEW

spines were visible. Oral sucker subterminal, 310μ in diameter. Prepharynx absent; pharynx well developed, 124μ wide. Esophagus 155μ long, the anterior end being dilated to almost the width of the pharynx. Intestinal ceca moderately wide, sinuous, with a distinct median bend at the level of the testes, and terminating 300μ to 337μ from the posterior end of body. Testes similar in shape, 187μ to 210μ long by 30μ to 38μ wide, largely intracecal, and with their ends deeply lobed, giving them an irregular X shape. Cirrus pouch thin-walled, oval, 100μ long by 80μ wide, and situated in the median line immediately in front of ovary. Ovary deeply lobed, 128μ to 180μ long by 75μ to 125μ wide, and situated to the left of the median line a short distance in front of the testes. Receptaculum seminis and Laurer's canal apparently absent. The uterus consists of a descending limb which runs in irregular coils to near the posterior end of body where it turns and proceeds forward in the same manner as an ascending limb, passing between the testes and between the ovary and cirrus pouch to a short distance behind the intestinal bifurca-

tion. The genital pore is situated immediately in front of the cirrus pouch and to the right of the median line. The vitellaria are composed of small uniform follicles and extend from a short distance behind the transverse muscular ridge to about one-third of the body length from the posterior end. Eggs oval, 22μ long by 11μ wide, yellowish brown in color.

Host.—Colymbus auritus.

Location.—Intestine according to label; probably urinary tract.

Distribution.—United States (Washington, D. C.).

Type specimens.—United States National Museum Helminthological Collection No. 29186; paratype No. 29187.

Eucotyle hassalli apparently occupies a position intermediate between *E. nephritica* (Mehlis) and *E. cohni* Skrjabin. In *E. nephritica* the testes are elongate, entirely extracecal, and partially encroach upon the vitelline fields, while in *E. hassalli* the testes are bifurcate at the poles, have their anterior part partly overlying the ceca, and are separated from the vitellaria by a distinct space. This species may be differentiated from *E. cohni* on the basis of body and egg sizes, *E. hassalli* being a much smaller form and the eggs about one-half the size of those of *E. cohni.*

EUCOTYLE WEHRI, new species

Specific diagnosis.—Eucotyle: Body elongate, 2.4 mm. long by 387μ wide; anterior end set off from remainder of body by a transverse

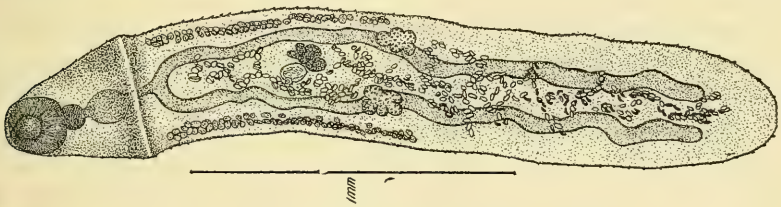

FIGURE 2.—EUCOTYLE WEHRI. VENTRAL VIEW

ridge 387μ from the anterior end. Cuticle covered with blunt spines measuring 7μ in length. Oral sucker subterminal, 170μ in diameter, weakly muscular. Prepharynx absent; pharynx 78μ in diameter. Esophagus 233μ long and provided with a dilation a short distance from the pharynx, the width of the dilation being slightly greater than that of the pharynx. Intestinal ceca sinuous and extending to about 210μ from the posterior end of body. Testes lobed, 112μ long by 75μ wide, partly extracecal but largely overlying the ceca, and situated near the equator of body. Cirrus pouch containing the seminal vesicle oval, 110μ long by 75μ wide, and situated in the median line to right of the ovary. Ovary lobed, 112μ long by 75μ wide, and situated to the left of the median line about 150μ in front of testes. Receptaculum seminis and Laurer's canal not observed.

The uterus pursues a course similar to that in *E. hassalli.* The genital pore is situated slightly to the right of the cirrus pouch. The vitellaria are composed of uniform follicles commencing a short distance caudad of the transverse muscular ridge and extending to about the equator of body. Eggs oval, brown in color, and from 30μ to 33μ long by 15μ to 18μ wide.

Host.—*Querquedula discors.*

Location.—Intestine according to label; probably urinary tract.

Distribution.—United States (Miles City, Mont.).

Type specimen.—United States National Museum Helminthological Collection No. 29188.

E. wehri resembles *E. zakharowi* Skrjabin in body form and extent of the vitellaria, but may be differentiated from this species by its smaller body size and position of testes. The testes are separated from each other by the width of the intercecal space in *E. wehri* while in *E. zakharowi* they occupy the entire body width.

For the purpose of separating the species described in this paper from those previously described the following key is appended:

KEY TO THE SPECIES OF EUCOTYLE COHN, 1904

1. Vitellaria extending to posterior border of testes ..... 2.
   Vitellaria extending to beyond posterior border of testes ..... 3.
2. Body 5.6 mm. long by 1.1 mm. wide; testes occupy entire width of body; uterine coils closely packed ..... **E. zakharowi.**
   Body 2.4 mm. long by 387μ wide; testes separated by width of intercecal space; uterine coils few ..... **E. wehri.**
3. Testes elongated but not lobed, entirely extracecal ..... **E. nephritica.**
   Testes lobed, partly overlying ceca ..... 4.
   Testes X-shaped; ovary larger than testes; egg 22μ by 11μ ..... **E. hassalli.**
   Testes irregular in shape; ovary smaller than testes; egg 43μ by 16μ. **E. cohni.**

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NEW LAND AND FRESH-WATER MOLLUSKS FROM SOUTH AMERICA

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The *Bulimulus*, the *Planorbis*, and the *Diplodom* herein described are from Uruguay and were received from Dr. Florentino Felippone of Montevideo. The *Ampullaria* and the *Anodontites* are from the Republic of Colombia and were received from Dr. R. H. Palmer of Cartagena. One species of *Odontostomus* is from Uruguay and was received from Prof. Auguste Teisseire of Colonia. The other species of *Odontostomus* and the *Drymaeus* come from Bolivia and Argentina and were received from G. L. Harrington, of General Ballivian, Argentina.

BULIMULUS (BULIMULUS) FELIPPONEI, new species

Plate 1, Figure 9

Shell thin, slender, whorls 7½, apex minutely granulated, the granules arranged in oblique transverse series and in obscure spirals. Whorls moderately rounded, the body whorl more than half the length of the shell; sutures well impressed. Sculpture of faint longitudinal lines of growth, the rest periods numerous and indicated by minute riblets, the spiral sculpture of numerous miscroscopic striae. Aperture elongate, outer lip simple, columella nearly erect, reflected over and nearly closing the umbilicus. Color nearly white, the four upper whorls of a rusty tint.

The type (Cat. No. 380691, U.S.N.M.) measures: Length, 19 mm.: diameter, 7 mm.; length of aperture, 6 mm.; width of aperture, 4 mm. It and a paratype (Cat. No. 380692, U.S.N.M.) and a third specimen (Cat. No. 365729, U.S.N.M.) came from Fray Bentos, Department of Rio Negro, Uruguay, and were presented by Dr. Florentino Felippone.

The species is nearest to *Bulimulus krebsianus* Pilsbry, of Venezuela. It is related also to *Bulimulus tenuissimus* Lea, but is much more slender.

DRYMAEUS HARRINGTONI, new species

Plate 1, Figure 7

Shell rather thin, translucent, of stout form, ovate-fusiform. Aperture equal to the spire. Apical whorls regularly grated by vertical and spiral lines. Whorls 6½, slightly convex, body whorl somewhat flattened behind the aperture. Sutures linear, not deep. Sculpture of numerous nearly regular longitudinal growth lines and faint indications of spiral striae. Ground color nearly white with flames, bands, and spots of chestnut and blackish brown or purple. On the back of the body whorl the dark color is arranged in five broad bands. On the rest of this whorl it is in longitudinal, jagged bars; on the upper whorls it is arranged in spiral bands of small squarish chestnut spots. The interior is whitish with the five bands of the exterior prominent. Umbilicus narrow. Aperture nearly vertical, slightly drawn down at base. Lip a little expanded and reflected. Columella broadly expanded and almost concealing the umbilicus. Parietal wall with a thin callus.

The type (Cat. No. 380701, U.S.N.M.) measures: Length, 35 mm.; diameter, 17 mm.; length of aperture, 17.5 mm. It comes from General Ballivian, Province of Salta, Argentina, and was collected and presented by G. L. Harrington.

Its nearest relatives are *Drymaeus abyssorum* Orbigny and *Drymaeus hygrohylaeus* Orbigny, both of which inhabit the same general region.

ODONTOSTOMUS (PLAGIODONTES) TEISSEIREI, new species

Plate 1, Figure 3

Shell elongate, the spire tapering, the body whorl on the back tapering, pinched to an angle at the base. Umbilicus openly rimate; whorls 8½, rather flatly convex, sutures linear, irregularly crenate, whitish; sculpture of faint longitudinal striae, without spiral sculpture. Aperture nearly vertical, outer lip slightly curving, basal lip abruptly rounded, columellar lip oblique, angular at the left, in front view completely concealing the umbilicus. Color nearly white, the sutures still lighter. Aperture pure white, reflected edge thickened, nearly filled with eight teeth, three of which are large and twisted, as follows: A large 2-ribbed tooth on the parietal wall, its lower edge continuing as a twisted plate for about 4 mm. within the shell. A broad, twisted tooth at the middle of the outer lip, its upper edge continuing within for about 2 mm.; a very broad, tongue-like tooth on the columella bearing a minute denticle on its face, its lower and upper edges continued as ribs twining about the columella within the shell nearly to the base of the penultimate whorl. The

aperture contains also five smaller teeth, namely, two very small ones at the upper portion of the outer lip, two thin teeth near the base of the outer lip, and a platelike tooth curving into the shell at the base of the columellar lip. Deep within the aperture on the wall of the body whorl is an obliquely set lamina about 7 mm. long. This lamina and all the teeth in the outer lip show like white scars through the wall of the body whorl. The true condition of the armature within the shell can be seen only by breaking away a portion of the back of the body whorl. A thick callus across the parietal wall.

The type (Cat. No. 380699, U.S.N.M.) measures: Height, 26 mm.; diameter, 8.75 mm.; height of aperture 10 mm. It comes from Punta Chaparro, Department of Soriano, Uruguay, and was presented by Prof. Auguste Teisseire. The species is related to *Odontostomus rocae*, Doering but is much more slender. Probably it is still more closely related to *Odontostomus multiplicatus* Doering, an unfigured species.

ODONTOSTOMUS (SPIXIA) CHUQUISACANA, new species

Plate 1, Figure 2

Shell long, tapering at top and at bottom. Thin, translucent. Whorls 8½, flatly rounded, the first four chestnut color, the others grayish-tawny. The apical and first three whorls are confusedly vertically costulate, malleate and spirally striate. Sutures well impressed. Longitudinal sculpture of numerous low, irregular, wavy, sometimes interrupted whitish folds. At the middle of each whorl the folds are somewhat weaker giving the appearance of a smoothish spiral band. Spiral sculpture almost lacking, but with faint indications of spiral striae. Body whorl contracted at the base, angulate around the umbilicus, a deep pit just behind the outer lip. Aperture subtriangular, narrow at the base, outer lip simple, nearly vertical, rounded just below its attachment to the body whorl; basal lip slightly expanded; columellar lip widely expanded, partly concealing the narrow umbilicus; a moderate callus across the parietal wall. The outer lip has a prominent tooth corresponding to the deep pit on its outer portion; the columella has a strong, platelike twisted tooth entering the aperture; the basal lip has a small callus corresponding to a shallow groove in the imbilical area; parietal wall without vestige of a tooth.

The type (Cat. No. 380700, U.S.N.M.), measures: Height, 17.5 mm.; diameter, 4.75 mm.

It came from Province of Chuquizaca, Bolivia, and was collected and presented by G. L. Harrington for whom the species is named.

Evidently closely related to *Odontostomus* (*Spixia*) *lemoinei* Ancey [1] from which it principally differs in having no tooth on the parietal wall.

PLANORBIS PAYSANDUENSIS, new species

Plate 1, Figures 1, 4, 6

Upper surface flattened, the center sunken, all the whorls showing in the central pit. Sutures deep, each whorl attached to the preceding whorl just below its roundly angulate upper edge, thus forming a spiral ridge into the pit. Under surface sloping inward, the umbilicus showing all the whorls, which descend into it as a narrow ridge. Sculpture of numerous transverse growth striae, with rest periods indicated by a slight thickening; spiral sculpture of nearly obsolete fine striae. Aperture nearly semielliptic, oblique slightly angled at the base, lip sharp. Color, upper surface pale straw; lower surface nearly white.

The type (Cat. No. 380693, U.S.N.M.) measures: Greater diameter, 15 mm.; smaller diameter, 12 m.; height 5 mm. It and a paratype (Cat. No. 380694, U.S.N.M.) came from Paysandu, Uruguay, and were presented by Doctor Felippone, who says they are rare. The paratype has the aperture uptilted, while the type has it horizontal. The inward sloping base and the low altitude as compared with diameter will serve to distinguish this species from all others of the Uruguayan region.

AMPULLARIA PALMERI, new species

Plate 1, Figures 5, 8

Shell large and thick, higher than wide. Whorls obscurely shouldered and obsoletely angled below the shoulder. Body whorl including about seven-eighths the height of the shell. Sutures well impressed. Longitudinal sculpture of moderately strong growth striae with several rest periods plainly marked, and emphasized by dark chestnut transverse bars just behind them. Concentric sculpture of nearly microscopic close-set, slightly waving, minutely granular striae, some of them, especially on the upper whorls, and at nearly regular intervals, are stronger and under a lens stand out as lines of spiral granules. On the body whorl these granules tend to coalesce to form continuous spiral lines much stronger than the minute spiral striae. Umbilicus not very wide, aperture somewhat elongate, auriform, outer lip sharp, thickened within; columella nearly erect, slightly reflected toward the umbilicus, a moderately thick callus across the parietal wall. Color mixed tints of olive and chestnut,

[1] Jour. Conch., vol. 7, 1892, p. 93, fig. 1; p. 97.

obscurely banded with chestnut. At the rest periods the bands become prominent and very dark. Interior rosy with the dark bands of the exterior showing lavender tints, the columella ochraceous buff, outer lip the same color with the dark banding much emphasized at the margin.

The type (Cat. No. 380696, U.S.N.M.) measures: Height, 65 mm.; diameter, 52 mm.; length of aperture, 45 mm.; width of aperture, 30 mm.

It and three paratypes (Cat. No. 380697, U.S.N.M.) and a lot of embryonic shells (Cat. No. 380698, U.S.N.M.) come from a small stream in a dense jungle, 13 kilometers south of Puerto Santos, Province of Santander del Norte, Republic of Colombia, and were collected and presented by Dr. R. H. Palmer.

The fine coloring, the slightly elongated form, and especially the microscopic sculpture of this species will serve to distinguish it.

DIPLODON YAGUARONIS, new species

Plate 2, Figures 2, 3, 5, 6

Shell elongate, nearly subelliptic, rather thin, rounded in front, obliquely subtruncate and roundly pointed at the rear. Beaks set about 13 mm. behind the extreme front end of the shell and 50 mm. in front of the extreme back end. Beaks sculptured with strong radiating ribs. (This sculpture is better shown in the three paratypes. It consists of about 20 ribs, covering practically all the young shell, the central pair joining to form a long V and continuing then for some distance as a single rib). Dorsal margin lightly arcuate, fading into both the anterior and posterior margins. Ventral margin very slightly curved, nearly straight, rounding into the anterior margin and making a rounded point with the posterior margin. Posterior ridge rather high, rounded. Anterior ridge not differentiated from the general surface, the descent to the anterior margin steep. Concentric sculpture as shown with a lens, of very fine growth striae, the rest periods plainly indicated by a slight elevating of the older portion of the shell above the newer portion, and accentuated by a deepening of color; lamellose on the anterior and posterior areas and as the ventral margin is approached. Color uniform dark chestnut, slightly glossy on middle portion. Interior of a bluish cast, iridescent, appearing to be radiately striated, the rest periods plainly showing as concentric ridges and perceptible to the touch. Anterior adductor scar deep; the posterior one superficial. Pallial line well marked at the front, obscure at the rear, set about 4 mm. from the ventral margin. Pseudocardinal tooth of left valve thin, tongue-shaped, fitting into the narrow groove formed

by the two thin, platelike pseudocardinals of the right valve. Lateral teeth of left valve long, subequal. The lateral tooth of right valve long, thin, rather high. Prismatic border a mere edging.

The type (Cat. No. 380554, U.S.N.M.) measures: Length, 63 mm.; height, 33 mm.; diameter, 21.5 mm. It and three younger paratypes (380756) come from Rio Yaguaron, Department of Cerro Largo, Uruguay, and were presented by Dr. Florentino Felippone.

The species is closely related to *Diplodon pilsbryi* Marshall, but is smaller, less pointed at the rear, and more nearly elliptic. The Rio Yaguaron flows into the Laguna Merim and forms most of the boundary between the Department of Cerro Largo, Uruguay and the State of Rio Grande do Sul, Brazil. The type locality of *Diplodon pilsbryi* is Canada Grande, the water of which also reaches Laguna Merim through the Rio Tacuary. The two species are thus geographically related as coming from the eastern drainage of Uruguay.

ANODOTITES PALMERI, new species

Plate 2, Figures 1, 4, 7

Shell rather thin, elongate, somewhat oblique, wide at the rear, much narrower in front. Dorsal margin lightly arched, ventral margin nearly straight, joining the posterior margin in a rounded point, and gently curving into the ventral margin which is abruptly rounded. Beaks set about 15 mm. behind the extreme anterior end 60 mm. in front of extreme posterior end. Posterior area with a low rib running from the beak to lower portion of posterior margin. Posterior ridge rounded, anterior ridge not differentiated from general surface. Anterior half of surface smoothish, with a dull unctuous polish; posterior portion with innumerable concentric lamellae of fugacious periostracum; concentric sculpture of many fine growth striae. Across the portion just in front of the middle are several puckered bands radiating from the beak to the ventral margin. Under compound microscope the periostracum shows the very fine radiating sculpture usual to the genus [2]. Color of surface uniform chestnut. Interior in poor condition, evidently iridescent, bluish, and flesh-colored. Sinulus triangular, prominent. Cavity of shell shallow. Adductor scars well impressed. Pallial line well-marked, about 8 mm. from the ventral edge. Prismatic border very narrow.

The type (Cat. No. 380695, U.S.N.M.) measures: Length, 75 mm.; height, 42 mm.; diameter, 24 mm. It comes from a small stream, in a dense jungle, 13 kilometers south of Puerto Santos, Province of

[2] Marshall, Microscopic Sculpture of Pearly Fresh-Water Mussel Shells: Proc. U. S. Nat. Mus., vol. 67 No. 2576, art. 4, 1925, pp. 1–14, pls. 1–4.

Santander del Norte, Republic of Colombia and was collected and presented by Dr. R. H. Palmer. A paratype (Cat. No. 380702, U.S.N.M.) is a younger specimen not quite so elongate.

Like *Anodontites irisans* Marshall, this species has a general resemblance in external characters to the well-known *Elliptio complanatus* (Solander) Dillwyn, of the eastern United States. The shell is related to *Anodontites irisans* in form, size and color, but bears across its surface radiating scalariform sculpture which is lacking in *irisans*. This sculpture relates it to *Anodontites tortilis* Lea, and *Anodontites pittieri* Marshall and it may for the present be classed in that group. The unfigured *Anodontites carinata* Philippi [3] probably is related to *Anodontites palmeri*, but its form, oval, nearly elliptic, serves to differentiate it.

EXPLANATION OF PLATES

PLATE 1

Figure 1. *Planorbis paysanduensis*, new species, × 2 diam.
2. *Odontostomus* (*Spixia*) *chuquisacana*, new species, × 2 dia.
3. *Odontostomus* (*Plagiodontes*) *teisseirei*, new species, nat. size.
4. *Planorbis paysanduensis*, new species, top view, × 2 diam.
5. *Ampullaria palmeri*, new species, sculpture, × 15 diam.
6. *Planorbis paysanduensis*, new species, × 2 diam.
7. *Drymaeus harringtoni*, new species, nat. size.
8. *Ampullaria palmeri*, new species, nat. size.
9. *Bulimulus felipponei*, new species, × 2 diam.

PLATE 2

All figures reduced 1/7

Figure 1. *Anodontites palmeri*, new species.
2, 3. *Diplodon yaguaronis*, new species.
4. *Anodontites palmeri*, new species.
5, 6. *Diplodon yaguaronis*, new species.
7. *Anodontites palmeri*, new species.

[6] Mal. Blatt., 1858, p. 225.

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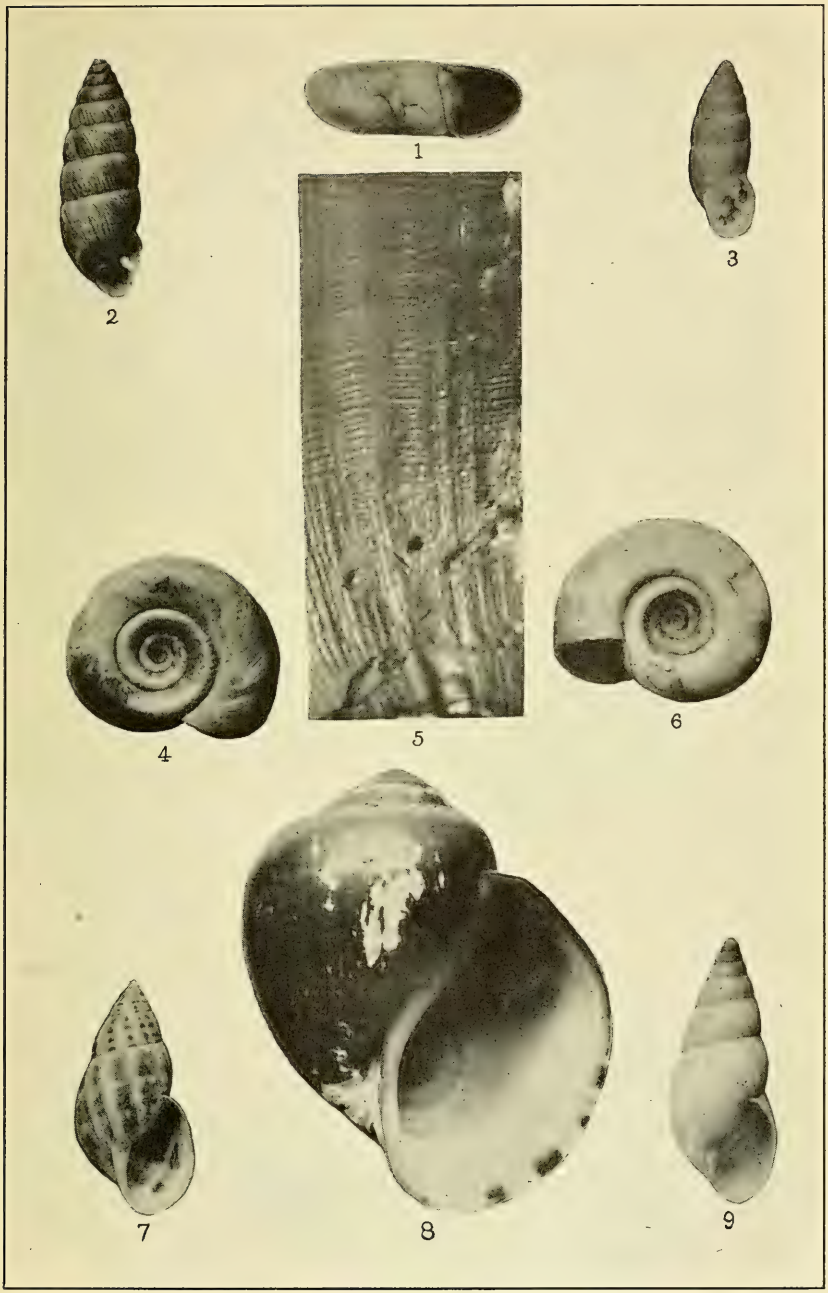
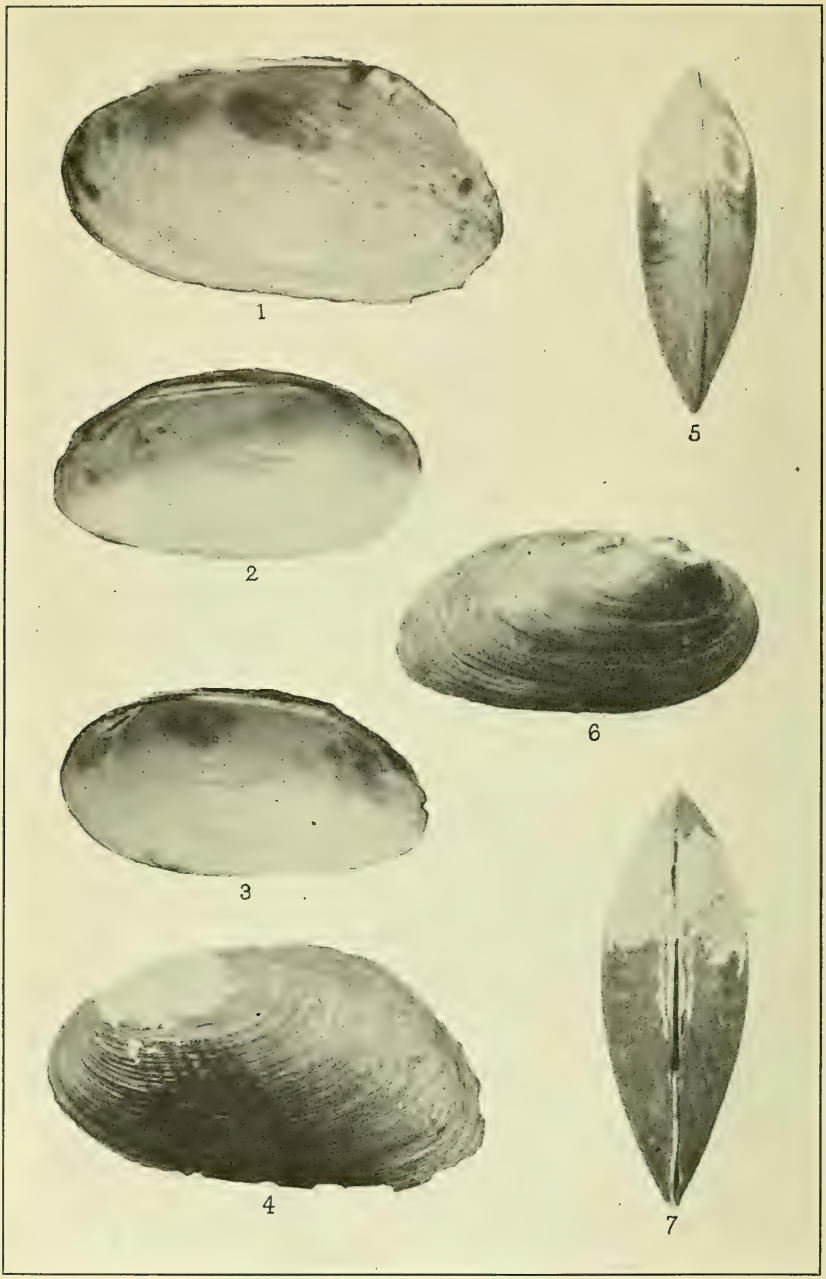


NEW MOLLUSKS FROM SOUTH AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 7



NEW MOLLUSKS FROM SOUTH AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 7

A REVISION OF THE NORTH AMERICAN SPECIES OF ICHNEUMON-FLIES OF THE GENUS ODONTOMERUS

By R. A. Cushman

Of the Bureau of Entomology, United States Department of Agriculture

This paper was originally planned as an attempt to straighten out the existing confusion as to the identity of the species in that group of *Odontomerus* Gravenhorst having entirely black body and red legs. Since, however, my studies indicate that few of the North American species are adequately described, I have expanded it to include discussion of all the species together with a specific key.

In the past ten years or a little more, three papers dealing with North American species of *Odontomerus* have appeared.

J. C. Bradley [1] discussed at some length the identity of the three species *mellipes* (Say), *vicinus* Cresson, and *canadensis* Provancher, concluding that *mellipes* and *vicinus* are good species and that *canadensis* is a synonym of *vicinus*. He also presented a key to all the North American species and described a new species, *albotibialis*, allied to *mellipes*.

S. A. Rohwer [2] overlooking Bradley's paper, revised the North American species, recognizing ten species, synonymizing his own *errans* with *mellipes*, and considering *mellipes*, *canadensis*, and *vicinus* as distinct species. The last mentioned, however, he recognized only in the male, confusing the female with what he called *canadensis*.

G. S. Walley [3] in a note on *mellipes* arrived at the conclusion that *canadensis* is synonymous with *mellipes*.

We thus have three workers, each with a fairly representative series of specimens, arriving independently at three different conclusions in regard to this group of three species.

In order, if possible, to straighten out the confusion, I have borrowed from Cornell University and the Canadian National collection the material on which Bradley and Walley based their conclusions and also the specimens in the collection of the Boston Society of Natural History and the Pennsylvania State Depart-

[1] Bull. Brooklyn Ent. Soc., vol. 13, 1918, pp. 100–104.
[2] Proc. U. S. Nat. Mus., vol. 57, 1920, pp. 454–460.
[3] Can. Ent., vol. 59, 1927, p. 74.

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ment of Agriculture. A careful study of this material together with the National Museum specimens studied by Rohwer is the basis of this paper.

I am forced to the conclusion that the females referred by the three authors to two species really include five species, *mellipes* (Say), *canadensis* Provancher, *vicinus* Cresson, and two undescribed species. In addition I find a sixth apparently distinct species, which none of the three other authors has seen.

The unique type of *albotibialis* Bradley I have not seen, nor have I found any specimen that agrees entirely with the description. It seems probable, however, that it comes within the range of variation of the species that I am calling *canadensis*.

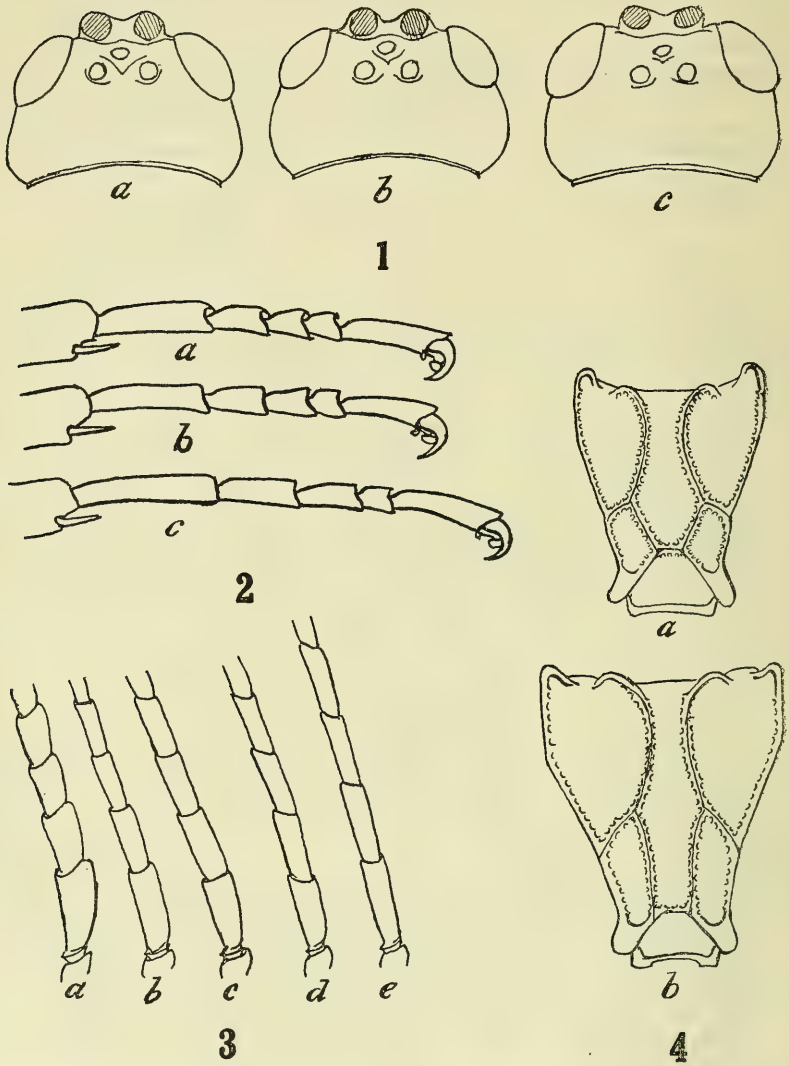
Since Rohwer has designated a neotype for *mellipes* I here accept that specimen as typical of the species. I have had no opportunity to examine the type of *canadensis*, but for the purpose of this paper I am accepting as that species the one represented by the majority of the specimens assigned to it by Rohwer, although, as will be pointed out later, there is some doubt of the correctness of the determination. I am in accord with Bradley as to the identity of the female of *vicinus*.

My thanks for the loan of material and permission to retain certain specimens are hereby extended to those in charge of the collections of Cornell University, the Boston Society of Natural History, the Canadian National collection, and the Pennsylvania State Department of Agriculture.

KEY TO THE NORTH AMERICAN SPECIES

1. Abdomen red, petiole sometimes blackish ..... 2.
   Abdomen black, rarely more or less reddish ..... 7.
2. Legs entirely black; apical joint of hind tarsus fully twice as long as third joint ..... **atripes** Rohwer (female).
   Legs largely red ..... 3.
3. Thorax strongly depressed; petiolar area barely a third as long as dorsal face of propodeum and nearly vertical; legs with very long hair in addition to the short pile; ovipositor much longer than body ..... **bicolor** Cresson.
   Thorax not or barely depressed; petiolar area much more than a third as long as dorsal surface and oblique; legs with long hairs at most on coxae and trochanters; ovipositor at most slightly longer than body ..... 4.
4. Coxae and trochanters black or piceous ..... 5.
   Coxae and trochanters red ..... 6.
5. Propodeum without distinct apophyses; ovipositor as long as body. **abdominalis** Cresson.
   Propodeum with distinct apophyses; ovipositor distinctly shorter than body. **brevicaudus**, new species.
6. Lateral impressions of pronotum not foveolate; cephalo-caudad length of temple about equal to that of eye ..... **strangaliae** Rohwer.
   Lateral impressions of pronotum strongly foveolate; cephalo-caudad length of temples distinctly greater than that of eye ..... **dichrous** Rohwer (female).

7. All coxae and trochanters, sometimes legs entirely, black or dark piceous--8.
   Legs red, rarely hind legs largely blackish, front and middle coxae and trochanters never black----------10.
8. Scutellum and basal lateral areas of propodeum densely, finely punctate; second and following tergites of male rather densely punctate.
   aethiops Cresson.
   Scutellum at most sparsely punctate, basal lateral areas polished and impunctate; second and following tergites in male practically impunctate--9.
9. Hind tarsus distinctly shorter than tibia, its basal joint about four times as long as thick; front and middle femora piceous; propodeal apophyses prominent----------**atripes** Rohwer (male).
   Hind tarsus fully as long as tibia, its basal joint about six times as long as thick; front and middle femora red; propodeal apophyses small.
   dichrous Rohwer (male).
10. Median carinae of propodeum very weak or obsolete; apophyses small.
    alaskensis Rohwer.
    Median carinae and apophyses well developed----------11.
11. *Female.*—Apical joint of hind tarsus twice as long as second joint (fig. 2*a*); basal flagellar joint fully a half longer than second, following joints not nearly twice as long as thick and much thicker at apex than at base (fig. 3*a*).
    Male.—Apical tarsal joint longer than second joint; basal flagellar joint much longer and distinctly thicker than second (fig. 3*b*)---**mellipes** (Say).
    Female.—Apical tarsal joint not nearly twice as long as second (fig. 2*b*, *c*); basal flagellar joint not nearly a half longer than second, following joints fully twice as long as thick and nearly or quite cylindrical (fig. 3*c*, *e*).
    Male.—Apical tarsal joint not or barely as long as second; basal flagellar joint conspicuously neither longer nor thicker than second (fig. 3*d*) ----------12.
12. Mesoscutum and scutellum densely punctate; antennae distinctly shorter than body, middle joints in female much less than twice as long as thick, in male barely twice as long as thick----------13.
    Mesoscutum and scutellum polished, at most very sparsely punctate; antennae nearly or quite as long as body and very slender, middle joints in female nearly or fully twice (in male more than twice) as long as thick----------14.
13. Hind tibia and tarsus black----------**tibialis**, new species.
    Hind tibia and tarsus red----------**punctatus**, new species.
14. Temples strongly flaring (fig. 1*a*); petiolar area in female much less than half as long as horizontal face of propodeum (fig. 4*b*); hind coxae and femora in male mostly black or piceous----------**vicinus** Cresson
    Temples at most only slightly wider than eyes (fig. 1*c*); petiolar area in female fully half as long as horizontal face of propodeum (fig. 4*a*); hind coxae and femora in male red (rarely the coxae and apex of femur are slightly piceous)----------15.
15. Second tergite regularly longitudinally striate at base--**striatus**, new species.
    Second tergite irregularly transversely wrinkled at extreme base------16.
16. Hind tibia red to fuscous, sometimes whitish below and rarely largely whitish or largely black, if largely whitish the ovipositor not much longer than the body ----------**canadensis** Provancher.
    Hind tibia distinctly whitish, fuscous only at apex; ovipositor much longer than body----------**albotibialis** Bradley.



FIGURES 1–4.—DETAILS OF ODONTOMERUS. 1, HEAD OF: *a*, VICINUS; *b*, MELLIPES; *c*, CANADENSIS. 2, HIND TARSUS OF FEMALE OF: *a*, MELLIPES; *b*, TIBIALIS; *c*, CANADENSIS. 3, BASE OF FLAGELLUM OF: MELLIPES, *a*, FEMALE, *b*, MALE; TIBIALIS, *c*, FEMALE, *d*, MALE; *e*, CANADENSIS, FEMALE. 4, DORSAL FACE OF PROPODEUM OF: *a*, CANADENSIS; *b*, VICINUS

ODONTOMERUS ATRIPES Rohwer

Odontomerus atripes ROHWER, Proc. U. S. Nat. Mus., vol. 45, 1913, p. 358; vol. 57, 1920, p. 456, female, male.

Odontomerus aethiops JOHNSON, Biol. Surv. of Mt. Desert Region, Part 1, The Insect Fauna, 1927, p. 137.

From any other of the species with red abdomen this species is very distinct in its entirely black legs. Structurally it is most similar to *mellipes* (Say).

Female.—Facial quadrangle about equal in length and breadth; head slightly broader across temples than across eyes; temples a little longer from front to back than short diameter of eye, strongly sparsely punctate; face coarsely confluently punctate; ocell-ocular line distinctly longer than postocellar line; antennae barely three-fourths as long as body, rather stout, middle joints of flagellum barely a half longer than thick, basal joint about twice as long as thick and about a third longer than second; pronotum polished, upper margin finely and sparsely punctate, impression foveolate; mesoscutum polished with a few punctures along the notauli; notauli obscurely foveolate posteriorly, the impression formed by their junction longitudinally striate; scutellum sparsely punctate; mesopleurum polished with very sparse punctures, sternum more densely punctate; metapleurum and sides of propodeum opaque, the former rugulose; propodeum dorsally mostly polished, rather short, the petiolar area more than half as long as horizontal face, slightly concave, apophyses thick and prominent; legs very stout; hind tarsus much shorter than tibia, apical joint fully twice as long as third; abdomen polished, first tergite transversely rugulose, apical tergites very finely punctate; ovipositor sheath almost exactly as long as body.

Black with legs black or piceous, abdomen red with first segment except apex black.

Male.—Sculpture throughout more distinct; antennae as long as body and slender with middle joints twice as long as thick, first joint of flagellum only slightly shorter than second; hind tarsus a little shorter than tibia, apical joint barely longer than second and much less than twice as long as third; abdomen entirely black.

A much undersized female in the National Collection (5 mm. long) has the legs pale reddish piceous.

The specimens examined include four females and two males, including the type and allotype, in the National Museum, two females in the Canadian National Collection, one female in the Cornell Collection, and two females and one male in the Collection of the Boston Society of Natural History.

These show a range from Quebec to Pennsylvania, the other province and States represented being Ontario, Maine, New Hampshire, Massachusetts, and New York.

The male in the collection of the Boston Society of Natural History is listed by C. W. Johnson as *aethiops* Cresson in the Mount Desert list.

ODONTOMERUS BICOLOR Cresson

Odontomerus bicolor CRESSON, Trans. Amer. Ent. Soc., vol. 3, 1870, p. 169.—PROVANCHER, Faune Ent. Can. Hym., 1883, p. 490.—BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 102.—ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 456, female.

The discussion of this species is based on the two Texan specimens mentioned by Rohwer, one of which was compared by him with the type and labelled a homotype. I have not seen the type.

Thus far the male is unknown, but the female is very distinct. A few of its characteristic features are used in the key. Others are as follows: Head behind eyes broader than at eyes, the temples longer from front to back than short diameter of eyes; face and temples coarsely punctate, the punctures on the face more dense but not crowded; postocellar and ocellocular lines about equal and nearly twice as long as diamter of an ocellus; flagellum very slender with all joints strongly elongate, the basal joint only a little longer than second; head, thorax, petiole, and legs with very long suberect hair that is especially conspicuous on the legs; thorax so depressed that it is conspicuously broader than deep with its dorsal and ventral surfaces distinctly flattened, its dorsal line in profile nearly straight from prescutum to apical carina of propodeum; metapleurum and sides of propodeum coarsely rugoso-punctate; mesoscutum, scutellum, pleurum, and sternum polished and sparsely punctate; notauli strongly foveolate; propodeum with its upper surface unusually long and flat, the combined median areas correspondingly long and narrow and only slightly constricted at junction of basal area and areola; carinae defining the very short vertical petiolar area strong, with elevations at the intersections of the longitudinal carinae; hind femur very thick, with a roundly elevated denticulate keel behind the rather slender tooth; apical joint of hind tarsus distinctly longer than second but not fully twice as long as third; second and third tergites very finely transversely aciculated; ovipositor fully a half longer than body.

ODONTOMERUS ABDOMINALIS Cresson

Odontomerus abdominalis CRESSON, Proc. Ent. Soc. Philadelphia, vol. 4, 1865, p. 289.—ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 456, female.

The specimens referred to this species by Bradley are *strangaliae* Rohwer. In his paper Bradley mentions only two specimens, but in

the Cornell Collection there are two specimens of *dichrous* Rohwer determined by him as *abdominalis*.

The type of *brevicaudus*, new species, described below, was compared with the type of *abdominalis* for me by Miss Grace Sandhouse on a recent visit to Philadelphia. About the only differences noted are the longer ovipositor in *abdominalis* (as long as body) and its lack of apophyses on the propodeum. I have not examined the type.

ODONTOMERUS BREVICAUDUS, new species

Female.—Length 7 mm.; antennae 6 mm.; ovipositor 6 mm. Very closely related to *dichrous* Rohwer and perhaps only somewhat unusual specimens of that species but the two females before me differ constantly from that species as follows: First flagellar joint barely, second much less than, twice as long as thick; mesoscutum, scutellum, and basal lateral areas of propodeum evenly, finely punctate; entire mesopleurum except speculum distinctly punctate; hind femur stouter; tarsus much shorter than tibia; its basal joint little more than three times as long as thick; ovipositor distinctly shorter than body.

Color as in *dichrous*, black with abdomen and legs reddish, coxae and trochanters piceous, and wings somewhat infumate.

Type-locality.—Hedley, British Columbia.

Type.—Canadian National Collection.

Paratype.—Cat. No. 42033, U.S.N.M.

Two specimens, the type taken July 23, 1923, by C. B. Garrett, and the paratype captured by H. L. Seamans at Waterton, Alberta, on July 10, 1923.

In the paratype the left antenna is entirely missing and of the right only the scape and pedicel are present. It is about 10.5 mm. long with ovipositor 9 mm.

ODONTOMERUS STRANGALIAE Rohwer

Odontomerus strangaliae ROHWER, Proc. U. S. Nat. Mus., vol. 53, 1917, p. 457, female.

Odontomerus abdominalis BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 103 (part).

This eastern species is very closely allied to the western *dichrous* Rohwer, perhaps only a variety of that species. However, it appears to differ constantly in the lack of foveolation in the pronotal impression; in having the temples and mesopleurum and sternum very sparsely punctuate; the petiolar area nearly or quite as long as broad and more than half as long as the horizontal surface of propodeum, the nervulus interstitial; and the tarsi slightly more slender, though the proportionate length of the joints is about the same as in *dichrous*. Usually also the temples are slightly shorter from

front to back, being subequal to the short diameter of the eye; and the ovipositor slightly shorter, being normally almost exactly as long as the body.

Palpi stramineous; coxæ always red.

All three of the characters employed by Rohwer in his key to species for distinguishing *dichrous* and *strangaliae* are subject to such variation that they are unusable.

These observations are based on eleven specimens, including the type, in the National Collection, five from the Cornell University Collection, and three from the Canadian National Collection.

The male is unknown.

The distribution of this species as indicated by the specimens examined is from Quebec to Virginia, specimens being at hand from Quebec, Ontario, New York, Pennsylvania, Maryland, and Virginia.

ODONTOMERUS DICHROUS Rohwer

Odontomerus dichrous ROHWER, Proc. U. S. Nat. Mus., vol. 45, 1913, p. 361; vol. 57, 1920, p. 457, female.

This and *strangaliae* Rohwer may be western and eastern varieties of the same species, but, as pointed out under the latter species, they are easily distinguished by several characters that appear to be constant for the material examined.

Female.—Temples usually distinctly punctate, distinctly longer from front to back than the short diameter of the eye; malar space a little shorter than basal width of mandible; ocell-ocular line longer than postocellar line, diameter of an ocellus hardly two-thirds as long as ocellocular line; antennae about five-sixths as long as body, first flagellar joint about two and a half times as long as thick and a third longer than second; pronotum strongly foveolate in lateral impression and rather coarsely punctate in humeral angle; mesopleurum below and sternum strongly punctate; mesoscutum and scutellum polished, very sparsely punctate, notauli indistinctly foveolate; metapleurum rugose, opaque; propodeum polished, basal lateral areas very sparsely punctate, pleural areas more or less roughened, petiolar area sometimes rugose throughout, broader than long and barely half as long as horizontal surface of propodeum; nervulus antefurcal; hind tarsus hardly as long as tibia, basal joint about four times as long as thick, fifth much longer than second and about twice as long as third; ovipositor a little (about one-tenth) longer than body.

Palpi usually more or less infuscate; coxae frequently more or less piceous.

Male.—Heretofore this species has been known only in the female. The National Collection contains a single male that appears to be of this species. It differs from the female much as does the male of *atripes* Rohwer. The abdomen is black, the hind legs are nearly black, and the wings nearly hyaline. From the male of *atripes* it is easily distinguished by its red front and middle femora, more slender hind femur, longer and more slender hind tarsus, and the weakly developed propodeal apophyses. From the male of *vicinus* Cresson, which it closely resembles, its narrower temples and black front and middle coxae sufficiently distinguish it.

The male specimen described above was taken at Kaslo, British Columbia, by H. G. Dyar.

The foregoing discussion is based on seven females and one male in the U. S. National Museum, two females in the Cornell Collection, and two females in the Canadian National Collection. All of these specimens are from the States of Washington and Idaho and the Province of British Columbia.

ODONTOMERUS AETHIOPS Cresson

Odontomerus aethiops CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 289.—ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 457, female, male.

Sufficiently distinct, in the female, from any of the other North American species by its entirely coal-black body and legs, to make detailed discussion unnecessary. In most details of structure it is very similar to *atripes* Rohwer. I have not seen the male, though judging from the original description its deep black color, especially of the legs, and punctate abdomen would distinguish it from the other black-legged males.

As pointed out under *atripes* the specimen recorded by Johnson in the Mount Desert list as *aethiops* is a male of *atripes*.

ODONTOMERUS ALASKENSIS Rohwer

Odontomerus alaskensis ROHWER, Proc. U. S. Nat. Mus., vol. 45, 1913, p. 360; vol. 57, 1920, p. 457.

Only the two specimens of the type series are known. It is very distinct from any of the other species by reason of the obsolete median and basal carinae of the propodeum. Other significant characters not noted by Rohwer are as follows: Temples almost flaring; basal joint of flagellum barely longer than second joint; thorax distinctly depressed, horizontal face of propodeum flat, straight in profile and about four times as long as petiolar area, apical carina strong and practically without apophyses; base of

second discoidal cell unusually broad; first tergite very short and broad, flattened above.

ODONTOMERUS MELLIPES (Say)

Figs. 1*b*, 2*a*, 3*a*, and *b*

Anomalon mellipes SAY, Contrib. Maclur. Lyc. Phila., vol. 2, 1828, p. 75 (LeConte Ed., vol. 1, p. 378), female.

Odontomerus mellipes CRESSON, Trans. Amer. Ent. Soc., vol. 3, 1870, p. 168.

Odontomerus errans ROHWER, Proc. U. S. Nat. Mus., vol. 45, 1913, p. 360, female.

Odontomerus mellipes BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 103, female, male (part).—ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 458, female, male (part).—WALLEY, Can. Ent., vol. 59, 1927, p. 74 (part).

Odontomerus canadensis ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 458, male (part).

This is the *mellipes* of Rowher's neotype.

The characters of the tarsi and antennae as employed in the foregoing key are far more reliable than the characters of the head and first tergite used by Rohwer.

Female.—Head distinctly broader across temples than across eyes but temples not distinctly flaring; face and base of clypeus densely punctate, temples sparsely so, apex of clypeus transversely rugulose; postocellar line much shorter than ocell-ocular line; facial quadrangle at least as broad as long; antennae stout, strongly tapering toward apex, much shorter than body, first joint of flagellum hardly twice as long as thick at apex and fully a half longer than second, other joints all much less than twice as long as thick, middle joints little longer than thick, those toward base much thicker at apex than at base. Thorax polished, mesoscutum, scutellum, upper margin of pronotum, lower mesopleurum and sternum finely and sparsely punctate, metapleurum irregularly rugulose opaque; propodeum polished and usually more or less punctate dorsally, more rugulose and subopaque laterally; legs very stout, hind femur nearly or quite half as deep (measured across apex of tooth) as long; hind tarsus much shorter than tibia, apical joint nearly twice as long as second, that of middle leg more than twice as long as second, front tarsus exclusive of claws very little longer than tibia. Abdomen rather stout, subpolished; first tergite hardly two and a half times as long as broad at apex, evenly arched above, longitudinal striate laterally, the striae bending inward posteriorly and sometimes crosses over the middle, sternite extending only a short distance beyond the spiracle; second tergite more or less transversely wrinkled at base; apical tergites very finely pilose and punctate; ovipositor sheath ordinarily slightly shorter than body.

Black; apical portion of clypeus and labrum reddish; flagellum brown; palpi fusco-luteous; wings dilutely infumate; legs testaceous,

front and middle pairs, especially tibiae, paler, tarsi and extensor surface of hind tibia sometimes more or less infuscate; membranous apical portion of tergites sometimes whitish, giving the abdomen a transversely banded appearance.

Male.—Antennae slender, nearly as long as body, flagellar joints nearly cylindrical, first joint a little more than twice as long as thick, distinctly thicker than, and one and a half times as long as, second, middle joint distinctly less than twice as long as thick; legs, especially tibiae and tarsi, much more slender than in female and hind tarsus less distinctly shorter than tibia, apical joint only about a half longer than second, that of middle leg hardly twice as long as second joint, front tarsus distinctly longer than tibia; first tergite three or four times as long as broad, only slightly arched above spiracles, longitudinally striate to apex, sternite extending beyond spiracle more than half way to apex; color as in female.

The foregoing discussion and description are based on 27 females and 4 males in the National Museum, 10 females and one male in the Cornell Collection, one female and three males in the Canadian Collection, and three females in the collection of the Pennsylvania Department of Agriculture. These 38 females and 8 males show a range of from 8 to 13 mm. for females and 6 to 10 mm. for males.

The distribution indicated by these specimens and by published records is from Nova Scotia and South Dakota to North Carolina and Arkansas.

ODONTOMERUS TIBIALIS, new species

Figs. 2*b*, 3*c*, and *d*

Odontomerus canadensis ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 458, male (part).—BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 12, male (part).

Odontomerus mellipes (SAY) WALLEY, Can. Ent., vol. 59, 1927, p. 74, female (part).

Because of its entirely black hind tibia and tarsus this may prove to be the true *canadensis* Provancher, but Provancher described his species as being brilliantly polished, and one of the most striking features of the present species is its punctate mesoscutum and scutellum. It seems hardly likely that Provancher would have overlooked this sculpture if it were present in his specimens.

Five of the males of the type series were placed by Rohwer under *canadensis*, and one of them was compared by him with Provancher's male. The females here described have been received since Rohwer made his study of the genus. Walley had the species confused with *mellipes*.

Female.—Length 11 mm. Head about as in *mellipes*, but postocellar line about three-fourths as long as ocell-ocular line; facial

quadrangle slightly longer than broad; antennae more slender, first joint of flagellum more than twice as long as thick and barely a third longer than second, all other joints present much longer than thick and nearly cylindrical. Mesoscutum and scutellum densely punctate, sculpture of thorax otherwise as in *mellipes;* hind femur nearly half as deep as long; hind tarsus nearly as long as tibia, apical joint barely a half longer than second joint, front tarsus much longer than tibia. Abdomen about as in *mellipes* except that first tergite is less regularly striate; ovipositor sheath equal to length of body.

Color as in *mellipes* except that antennae, palpi, hind tibia and tarsus, and apex of femur are black.

Male.—Length 10 mm. Flagellum slender, the joints cylindrical and all fully twice as long as thick, first joint only slightly thicker and longer than second; apical joint of hind tarsus hardly as long as second joint; abdomen distinctly punctate; first tergite about four times as long as broad; color as in female.

Type-locality.—Echo Lake, Mount Desert, Maine.

Allotype-locality.—Pisgah Ridge, North Carolina.

Type.—Cat. No. 42034, U.S.N.M.

Paratypes.—In Canadian National Collection and Cornell University.

Described from three females and eight males as follows: Type female captured June 27 by C. W. Johnson; paratype *a* (female) from Aylmer, Quebec, June 7, J. N. Knull; paratype *b* (female) without data; allotype male and paratypes *c–f* (male) reared by W. F. Fiske on June 4, 1905, from larvae of a Melandryid in fir, under Hopkins U. S. No. 35684; paratype *g* (male) Sudbury, Ontario; paratype *h* (male) Ithaca, New York, May 31, 1913; and paratype *i* (male) Montreal, Canada.

Paratype *c* was compared by Rohwer with Provancher's male of *canadensis* and determined as that species.

Paratypes *a* and *g* are in the Canadian National Collection and paratypes *h* and *i* in the Cornell University Collection.

All the females are very nearly of the same size, while the males range from 6 to 13 mm.

ODONTOMERUS PUNCTATUS, new species

Odontomerus mellipes ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 458, female (part).

Odontomerus canadensis ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 458, female (part).

The type of this species was confused by Rohwer with *mellipes* (Say), and one of the paratypes with *canadensis* Provancher. It is, however, very distinct from those species by the characters used in

the foregoing key. In nearly all respects it is very similar to *tibialis*, and is possibly only a western variety of that species.

Female.—Differs from *tibialis* practically only in that the legs are entirely red and the abdomen distinctly punctate.

Type-locality.—Priest River, Idaho.

Type.—Cat. No. 42035, U.S.N.M.

Paratype b.—Canadian National Collection.

Three females; the type reared under Hopkins U. S. No. 1042 *a* from *Leptura obliterata* Haldeman in grand fir; Paratype *a* taken at Collins, Idaho, July 28, 1898, by C. V. Piper; and Paratype *b* at Lorna, British Columbia, July 31, 1924, on *Picea engelmanni* by R. Hopping, and bearing the number 17203, lot 30.

ODONTOMERUS CANADENSIS Provancher (Rohwer)

Figs. 1*c*, 2*c*, 3*e*, and 4*a*

Exochus propinquus (Cresson) PROVANCHER, Nat. Can., vol. 7, 1875, p. 138, male.

Odontomerus canadensis PROVANCHER, Nat. Can., vol. 9, 1877, p. 16; vol. 12, 1880, p. 102; Faune Ent. Can., 1883, p. 490, female, male.

Odontomerus mellipes (SAY) BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 103, female, male (part).

Odontomerus canadensis ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 458, female, male (part).

Odontomerus mellipes (SAY) WALLEY, Can. Ent., vol. 59, 1927, p. 74 (part).—JOHNSON, Biol. Survey of Mount Desert Region, Part 1, 1927, p. 137.

Odontomerus canadensis JOHNSON, Biol. Survey of Mount Desert Region, Part I, 1927, p. 137.

This is *canadensis* as represented by a large majority of the specimens placed under the name by Rohwer. If it is conspecific with Provancher's female type that specimen is rather unusual in the color of the hind tibiae. Some of the smaller females have the hind tibia blackish above and whitish below but none has it entirely black as described for the type. A few specimens have the hind tibia whitish except at apex but have not the length of ovipositor as described for *albotibialis*.

In the female it can be distinguished from *mellipes* as follows: Body and legs not quite so stout; head not or barely wider behind eyes than at eyes; postocellar line very nearly as long as ocell-ocular line; facial quadrangle fully as long as broad; antennae nearly as long as body, slender with flagellar joints cylindrical, first joint about three times as long as thick and barely a fourth longer than second, all others at least a half longer than thick; mesoscutum and scutellum polished impunctate, sternum and lower pleurum very sparsely punctate; hind femur distinctly more than twice as long as deep; hind tarsus nearly as long as tibia, apical joint hardly a half longer than second joint, that of middle leg not twice as long as second, front tarsus much longer than tibia, first

tergite irregularly roughened, usually longitudinally impressed medially; ovipositor sheath fully as long as body but not much longer; palpi stramineous; hind tarsus black, apex of femur and extensor surface of tibia sometimes blackish, especially in small specimens, the under side whitish (entire tibia black according to Provancher).

In the male all the flagellar joints are at least twice as long as thick, and the first joint fully three times as long as thick and only slightly thicker and longer than the second; hind tarsus very nearly as long as tibia, apical joint not or barely as long as second; that of middle leg barely longer than second; first tergite five or six times as long as broad; hind tarsus, usually the tibia, and sometimes the femur dorsally, black or fuscous.

In the series assigned to this species there is great variation in the relative length and breadth of the first abdominal segment, especially in the female, but it is quite obviously variation and not of specific significance.

The foregoing discussion is based on 57 females and 57 males, of which 33 females and 26 males are in the National Museum, 7 females and 10 males from the Canadian National Collection, 8 females and 11 males from the Cornell Collection, 7 females and 10 males from the Boston Society of Natural History, and 2 females in the Pennsylvania State Collection.

This species is apparently distributed entirely across southern Canada and south to Oregon, Virginia, and New Mexico.

Rohwer's figure of the supposed female of *canadensis* is drawn from a specimen of *vicinus* Cresson. The head is poorly drawn in that it does not show the distinctly flaring temples of *vicinus*.

ODONTOMERUS STRIATUS, new species

Female.—Length 12 mm.

This may be nothing more than a somewhat anomalous specimen of *canadensis*, from dark legged specimens of which it differs practically only in having the postpetiole evenly convergently striate and the base of the second tergite evenly, finely, longitudinally striate. In the hind legs the femur at apex, the tibia above, and the entire tarsus are black, the lower side of tibia whitish.

Type-locality.—Lyme, Connecticut.

Type.—Cat. No. 42036, U.S.N.M.

One female taken by William Middleton on June 19, 1918.

ODONTOMERUS ALBOTIBIALIS Bradley

Odontomerus albotibialis BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 103, female.

Described from a single female specimen, which I have not seen.

Were it not for the great length of the ovipositor I would suspect it to be a variant of *canadensis*, for all of the other characters

ascribed to it by Bradley occur in one or another of the specimens of that species that I have examined.

ODONTOMERUS VICINUS Cresson

Figs. 1*a* and 4*b*

Odontomerus vicinus CRESSON, Trans. Amer. Ent. Soc., vol. 3, 1870, p. 168, male.—BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 102, female, male.—ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 457, male.

Odontomerus canadensis ROHWER, Proc. U. S. Nat. Mus., vol. 57, 1920, p. 458, fig. 12, female (part).

Bradley was correct in his association of the sexes, while Rohwer had the female associated with *canadensis*.

The very broad flaring temples appear at present to be sufficiently characteristic to distinguish the female of this species from any of the other species with black body and red legs, while the male is further characterized by the black hind legs.

It is the most slender of all this group of species, the first tergite in the female being three to three and a half times as long as broad, with the sternite reaching nearly half way between spiracle and apex; and the abdomen beyond distinctly narrower. The occiput is rather shallowly concave and about as broad as the head measured across the eyes, while the temples flare prominently; the antennae are about as long as the body and very slender. The notauli are posteriorly foveolate; the petiolar area of the propodeum is very short, the apical carina not arching toward the base medially but extending nearly straight across between the apophyses; the hind tarsus is very nearly as long as the tibia with second and apical joints about equal in length, the apical sometimes hardly as long as the second joint; the front tarsus is nearly a half longer than tibia with the apical joint hardly as long as the second; the ovipositor sheath is about a half longer than the body.

In the male the mesoscutum and scutellum are densely punctate and the abdomen entirely opaque granulose, with the basal tergites more or less rugulose.

The foregoing discussion is based on 12 females and 7 males in the United States National Museum, 16 females and 6 males in the Canadian National Collection, 3 females and 2 males from Cornell University, 2 females and 4 males from the Boston Society of Natural History, and 2 females in the Pennsylvania State Collection.

These specimens show a range from Quebec to Virginia, the following Provinces and States being represented: Quebec, Ontario, New Hampshire, Massachusetts, New York, Pennsylvania, Maryland, District of Columbia, and Virginia.

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THE LYSIANASSID AMPHIPOD CRUSTACEANS OF NEWFOUNDLAND, NOVA SCOTIA, AND NEW BRUNSWICK IN THE UNITED STATES NATIONAL MUSEUM

By Clarence R. Shoemaker

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Since 1905, when S. J. Holmes published his paper on the Amphipoda of the New England coast, very little has been done with the amphipod fauna of the east coast of America. While examining the amphipod collections in the National Museum, the great bulk of which are unidentified, I have been impressed by the great number of species, many of which appear to be new.

During the early days of the United States Fish Commission (now the Bureau of Fisheries) valuable dredgings were made off Newfoundland and Nova Scotia which proved to be very rich in amphipods. This material forms the basis of the present series of papers upon the amphipod fauna of Newfoundland, Nova Scotia, and New Brunswick, of which the present, comprising the family Lysianassidae, is the first.

Among the species represented by this family are two which appear to be new to science, and these I have designated as *Orchomene depressa* and *Orchomene macroserrata.*

Family LYSIANASSIDAE

ACIDOSTOMA LATICORNE G. O. Sars

1879. *Acidostoma laticorne* G. O. Sars, Arch. Naturv. Kristian., vol. 4, p. 440.

1885–86. *A. laticorne* G. O. Sars, Norske Nordhavs-Exp., vol. 6, Crust. I, p. 152, pl. 13, fig. 3, 3*a*, male.

Station 2481 steamer *Albatross*, east of Nova Scotia, 44° 07′ 30″ N., 57° 16′ 45″ W., July 5, 1885, 116 fathoms, gravel; 1 specimen.

This female specimen measures about 8.5 mm. As this sex has not been figured, I have made drawings in order to show wherein it differs from the male. Stebbing says of the genus *Acidostoma*[1]

[1] Tierreich, Amph., vol. 1, p. 14.

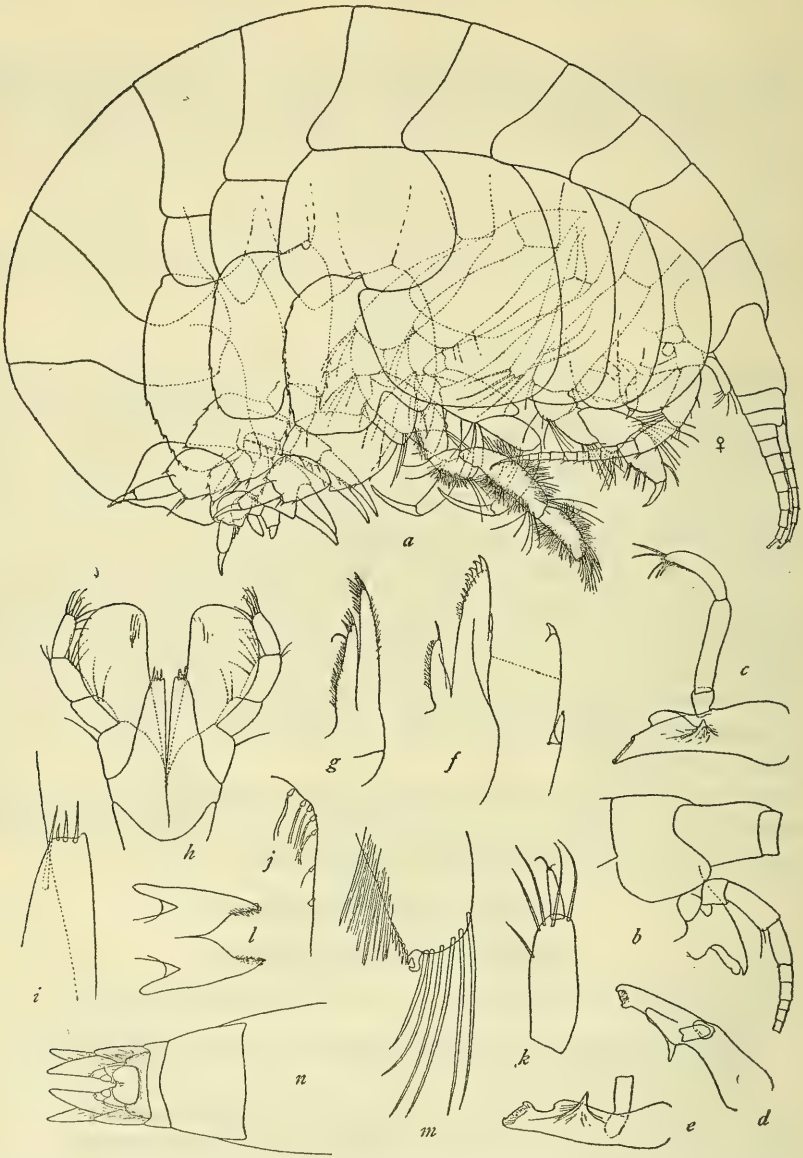

FIGURE 1.—ACIDOSTOMA LATICORNE. *a*, ENTIRE ANIMAL, FEMALE; *b*, HEAD AND EPISTOME; *c–e*, RIGHT MANDIBLE; *f*, MAXILLA 1; *g*, MAXILLA 2; *h*, MAXILLIPEDS; *i*, INNER PLATE OF MAXILLIPED, ENLARGED; *j*, OUTER PLATE OF MAXILLIPED, ENLARGED, SHOWING THE MINUTE TEETH; *k*, THIRD AND FOURTH JOINTS OF PALP OF MAXILLIPED, ENLARGED; *l*, LOWER LIP; *m*, END OF GNATHOPOD 2, ENLARGED, SHOWING UNGUIFORM SEVENTH JOINT; *n*, PLEON SEGMENTS 3–6, TELSON, AND UROPODS 2 AND 3

that the fourth joint of the palp of the maxillipeds is rudimentary, but in this female it is nearly half the length of the third joint and though rather small can scarcely be regarded as rudimentary. The outer plate of the maxillipeds is said to be without teeth, but in the present specimen there is a row of sparsely scattered very small weak teeth. Stebbing says the mandible possesses no molar, but in this specimen there is a prominent conical process which appears to represent the molar. As will be noticed, the palm of gnathopod 1 is defined by two long slender spines and is differentiated from the hind margin of the joint by a very low angle, and the palm throughout is armed with very fine, closely set teeth. Gnathopod 2 bears a very minute unguiform seventh joint.

ANONYX NUGAX (Phipps)

1774. *Cancer nugax* PHIPPS, Voyage North Pole, p. 192, pl. 12, fig. 2.

Grand Manan, U. S. Fish Commission, 1872; 1 speciman.

Grand Manan, between High Duck Island and Long Island, 8–9 fathoms, August 23, 1898, Mary J. Rathbun; 2 specimens.

Bay of Fundy, U. S. Fish Commission, 1872; 6 specimens.

Location 56–58 steamer *Speedwell*, Halifax harbor, off Herring Cove, between Mars Rock and Neverfail Shoal, August 25, 1877, 16 fathoms, sandy bottom; 1 specimen.

Location 59 steamer *Speedwell*, Halifax Outer Harbor one-fourth mile SSW. Rock Head buoy, August 28, 1877, 25 fathoms, gravel; 2 specimens.

Location 95 steamer *Speedwell*, Halifax Harbor, about one-fourth mile from shore off York Redoubt and Sandwich Point, September 13, 1877, 16 fathoms, very fine sand, ooze and red algae; 5 specimens.

Location 97 steamer *Speedwell*, Halifax Harbor, midway between York Redoubt and McNab's Island Light, September 13, 1877, 16 fathoms; 2 specimens.

Location 101 steamer *Speedwell*, off Halifax, Sambro Light, W. by N. one-fourth N. 9 miles, September 15, 1877, 42 fathoms, fine sand with Ophioglypha; 5 specimens.

Location 110 steamer *Speedwell*, Bedford Basin, September 21, 1877, 37 fathoms, fine sand and mud; 3 specimens.

Location 112–118 steamer *Speedwell*, Chebucto Head Light, NW. by W. about 8½ miles, September 24, 1877, 52 fathoms, fine sand and mud; 5 specimens.

Location 121 steamer *Speedwell*, Halifax Outer Harbor, September 27, 1877, 16 fathoms, sand, mud, and rocks; 1 specimen.

Station 2443 steamer *Albatross*, southeast of Newfoundland, 45° 44′ 00″ N., 49° 45′ 00″ W., June 25, 1885, 35 fathoms, white sand and broken shells; 2 specimens.

Station 2461 steamer *Albatross*, south of Newfoundland, 45° 47′ 00″ N., 54° 13′ 30″ W., July 3, 1885, 59 fathoms, fine sand and black specks; 1 specimen.

Station 2463 steamer *Albatross*, south of Newfoundland, 45° 44′ 00″ N. 54° 27′ 00″ W., July 3, 1885, 45 fathoms, broken shells; 3 specimens.

Station 2491 steamer *Albatross*, east of Nova Scotia, 45° 24′ 30″ N., 58° 35′ 15″ W., July 6, 1885, 59 fathoms, white sand; 1 specimen.

Station 2497 steamer *Albatross*, east of Nova Scotia, 45° 04′ 00″ N., 59° 36′ 45″ W., July 6, 1885, 57 fathoms, yellow sand, broken shells, hard; 23 specimens.

Station 2498 steamer *Albatross*, southeast of Nova Scotia, 44° 54′ 00″ N., 59° 46′ 45″ W., July 6, 1885, 65 fathoms, fine brown sand; 1 specimen.

Station 2499 steamer *Albatross*, southeast of Nova Scotia, 44° 46′ 30″ N., 59° 55′ 45″ W., July 6, 1885, 130 fathoms, black mud; 1 specimen.

ARISTIAS MICROPS G. O. Sars

1895. *Aristias microps* G. O. Sars, Crust. Norway, vol. 1, p. 675, pl. 1, fig. 2.

Station 2463 steamer *Albatross*, south of Newfoundland, 45° 44′ 00″ N., 54° 27′ 00″ W., July 3, 1885, 45 fathoms, broken shell; 1 specimen.

Sars gives 3 mm. for the length of this species; the present specimen, however, is 4.5 mm. *Aristias microps* has been recorded heretofore only from the west coast of Norway.

CHIRONESIMUS DEBRUYNII (Hoek)

1882. *Anonyx debruynii* Hoek, Niederl. Arch. Zool., suppl. 1, no. 7, p. 44, pl. 3, figs. 30–30*x*.

Bay of Fundy, U. S. Fish Commission, 1872; 1 specimen.

Station 2499 steamer *Albatross*, southeast of Nova Scotia, 44° 46′ 30″ N., 59° 55′ 45″ W., July 6, 1885, 130 fathoms, black mud; 1 specimen.

HIPPOMEDON PROPINQUUS G. O. Sars

1890. *Hippomedon propinquus* G. O. Sars, Crust. Norway, vol. 1, p. 57, pl. 21, fig. 1.

Bay of Fundy, U. S. Fish Commission, 1872; 4 specimens.

Location 56–58 steamer *Speedwell*, Halifax Harbor, off Herring Cove, between Mars Rock and Neverfail Shoal, August 25, 1877, 16 fathoms, sandy bottom; 5 specimens.

Location 72–73 steamer *Speedwell*, Halifax Harbor, Sandwich Point W. ½ N. ⅓ miles, September 4, 1877, 18 fathoms, fine sand; 1 specimen.

Location 95 steamer *Speedwell*, Halifax Harbor, about one-fourth mile from shore off York Redoubt and Sandwich Point, September 13, 1877, 16 fathoms, very fine sand, ooze, and red algae; 1 specimen.

Location 98 steamer *Speedwell*, Halifax Harbor, midway between Sandwich Point and McNab's Island Light, September 15, 1877, 18 fathoms, mud and fine sand; 5 specimens.

Location 101 steamer *Speedwell*, off Halifax, Sambro Light, W. by N. ¼ N. 9 miles, September 15, 1877, 42 fathoms, fine sand with Ophioglypha; 1 specimen.

Location 110 steamer *Speedwell*, Bedford Basin, September 21, 1877, 37 fathoms, fine sand and mud; 2 specimens.

Location 112–118 steamer *Speedwell*, Chebucto Head Light NW. by W. about 8½ miles, September 24, 1877, 52 fathoms, fine sand and mud; 3 specimens.

Station 2458 steamer *Albatross*, southeast of Newfoundland, 46° 48′ 30″ N., 52° 34′ 00″ W., July 2, 1885, 89 fathoms, sand, green mud; 5 specimens.

Station 2461 steamer *Albatross*, south of Newfoundland, 45° 47′ 00″ N., 54° 13′ 30″ W., July 3, 1885, 59 fathoms, fine sand and black specks; 2 specimens.

Station 2497 steamer *Albatross*, east of Nova Scotia, 45° 04′ 00″ N., 59° 36′ 45″ W., July 6, 1885, 57 fathoms, yellow sand, broken shells, hard; 10 specimens.

Station 2703 steamer *Albatross*, south of Nova Scotia, 44° 01′ 00″ N., 59° 02′ 30″ W., August 23, 1886, 140 fathoms, gray sand and black specks; 3 specimens.

HIPPOMEDON SERRATUS (Holmes)

1903. *Hippomedon serratus* Holmes, American Nat., vol. 37, p. 278.

1905. *Hippomedon serratus* Holmes, Bull. Bureau of Fisheries for 1904, vol. 24, p. 473, pl. 4, fig. 2, and text fig.

Grand Manan, August-September 1898, Mary J. Rathbun; 1 specimen.

ONISIMUS EDWARDSII (Kröyer)

1846. *Anonyx edwardsii* Kröyer, Naturh. Tidsskr., ser. 2, vol. 2, pp. 1, 41.

Location 43–46 steamer *Speedwell*, SE. ½ S. from Cape Sable about 30 miles, August 21, 1877, 90 fathoms; 7 specimens.

Grand Bank, 1879 (19), Osburn; 1 specimen.

Station 2443 steamer *Albatross*, southeast of Newfoundland, 45° 44′ 00″ N., 49° 45′ 00″ W., June 25, 1885. 35 fathoms, white sand and broken shells; 4 specimens.

ONISIMUS NORMANI (Schneider)

1891 and 1895, *Onisimus normani* (Schneider in MS.) G. O. Sars, Crust. Norway, vol. 1, p. 106, pl. 36, fig. 2; p. 686.

Location 42–46 steamer *Speedwell*, SE. ½ S. from Cape Sable about 30 miles, August 21, 1877, 88 fathoms (in *Urticina*); 21 specimens.

ONISIMUS PLAUTUS (Kröyer)

1845. *Anonyx plautus* Kröyer, Naturh. Tidsskr., ser. 2, vol. 1, p. 629.

Location 112–118 steamer *Speedwell*, Chebucto Head Light, NW. by W. about 8½ miles, September 24, 1877, 52 fathoms, fine sand and mud; 2 specimens.

Station 2458 steamer *Albatross*, southeast of Newfoundland, 46° 48′ 30″ N., 52° 34′ 00″ W., July 2, 1885, 89 fathoms, sand, green mud; 4 specimens.

Station 2461 steamer *Albatross*, south of Newfoundland, 45° 47′ 00″ N., 54° 13′ 30″ W., July 3, 1885, 59 fathoms, fine sand and black specks; 6 specimens.

Station 2491 steamer *Albatross*, east of Nova Scotia, 45° 24′ 30″ N., 58° 35′ 15″ W., July 6, 1885, 59 fathoms, white sand; 4 specimens.

Station 2497 steamer *Albatross*, east of Nova Scotia, 45° 04′ 00″ N., 59° 36′ 45″ W., July 6, 1885, 57 fathoms, yellow sand, broken shells, hard; 75 specimens.

Station 2499 steamer *Albatross*, east of Nova Scotia, 44° 46′ 30″ N., 59° 55′ 45″ W., July 6, 1885, 130 fathoms, black mud; 1 specimen.

OPISA ESCHRICHTII (Kröyer)

1842. *Opis eschrichtii* (Holböll in MS.) Kröyer, Naturh. Tidsskr., vol. 4, p. 149.

Station 2491 steamer *Albatross*, east of Nova Scotia, 45° 24′ 30″ N., 58° 35′ 15″ W., July 6, 1885, 59 fathoms, white sand; 1 specimen.

Station 2497 steamer *Albatross*, east of Nova Scotia, 45° 04′ 00″ N., 59° 36′ 45″ W., July 6, 1885, 57 fathoms, yellow sand, broken shells, hard; 2 specimens.

ORCHOMENE DEPRESSA, new species

Description.—Female.—Head, lateral angles rather broadly rounding, eyes oval, slightly narrower above, light yellowish-brown. Antenna 1, flagellum with about seven joints, accessory flagellum with three or four joints. Epistome very low, not projecting beyond upper lip. Mandible, molar low but well developed, accessory process not very prominent and not far in front of molar, palp set far back of molar. Maxilla 1, inner plate with two setae, outer plate

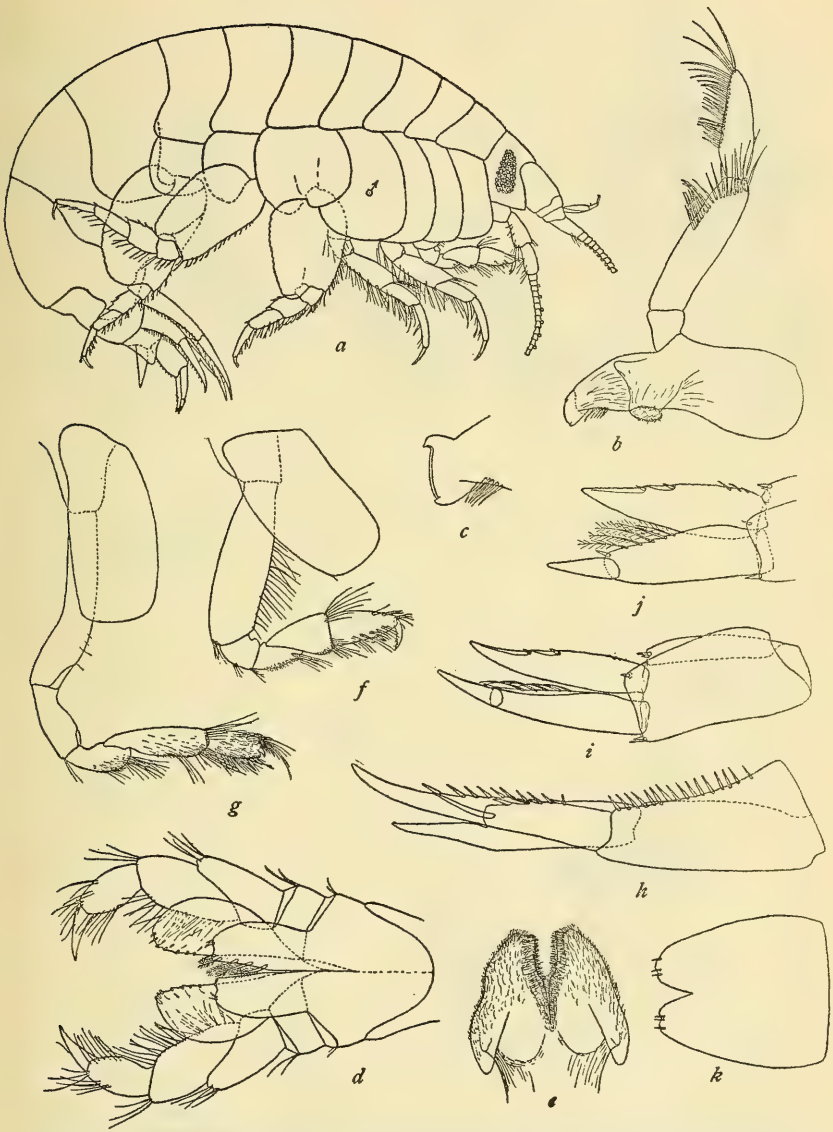

FIGURE 2.—ONISIMUS NORMANI. *a*, ENTIRE ANIMAL, MALE; *b*, RIGHT MANDIBLE; *c*, CUTTING EDGE OF RIGHT MANDIBLE, ENLARGED; *d*, MAXILLIPEDS; *e*, LOWER LIP; *f*, GNATHOPOD 1; *g*, GNATHOPOD 2; *h*, UROPOD 2; *i-j*, UROPOD 3; *k*, TELSON

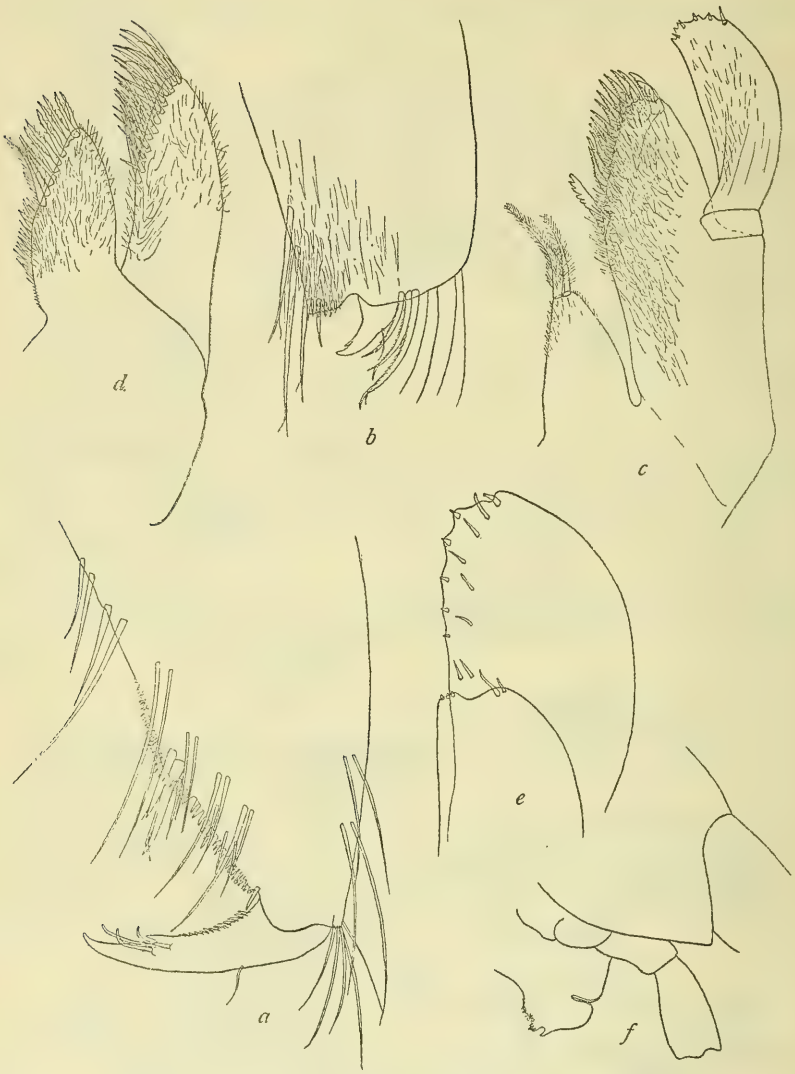

FIGURE 3.—ONISIMUS NORMANI. *a*, END OF GNATHOPOD 1, ENLARGED; *b*, END OF GNATHOPOD 2, ENLARGED; *c*, MAXILLA 1; *d*, MAXILLA 2; *e*, INNER AND OUTER PLATES OF MAXILLIPED, ENLARGED, SHOWING TEETH AND SPINES; *f*, HEAD AND EPISTOME

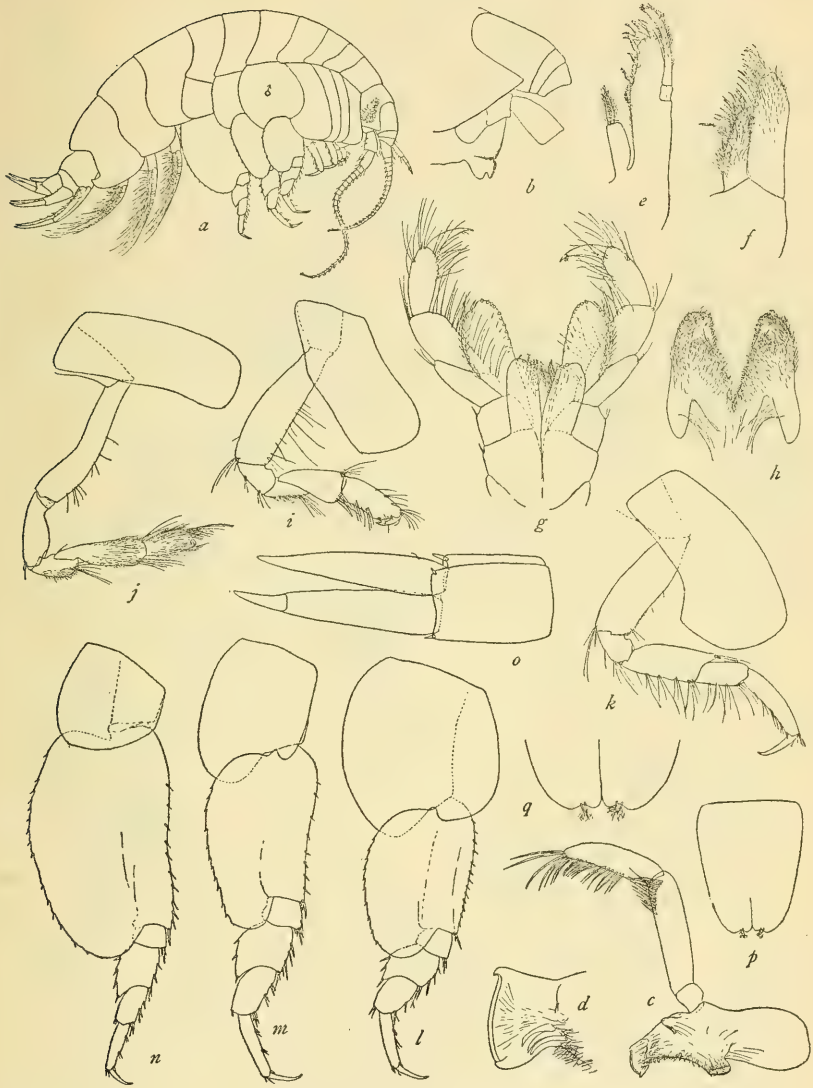

FIGURE 4.—ONISIMUS PLAUTUS. *a*, ENTIRE ANIMAL, MALE; *b*, HEAD AND EPISTOME; *c*, RIGHT MANDIBLE; *d*, CUTTING EDGE OF RIGHT MANDIBLE, ENLARGED; *e*, MAXILLA 1; *f*, MAXILLA 2; *g*, MAXILLIPEDS; *h*, LOWER LIP; *i*, GNATHOPOD 1; *j*, GNATHOPOD 2; *k*, PERAEOPOD 2; *l*, PERAEPOD 3; *m*, PERAEOPOD 4; *n*, PERAEOPOD 5; *o*, UROPOD 3; *p-q*, TELSON

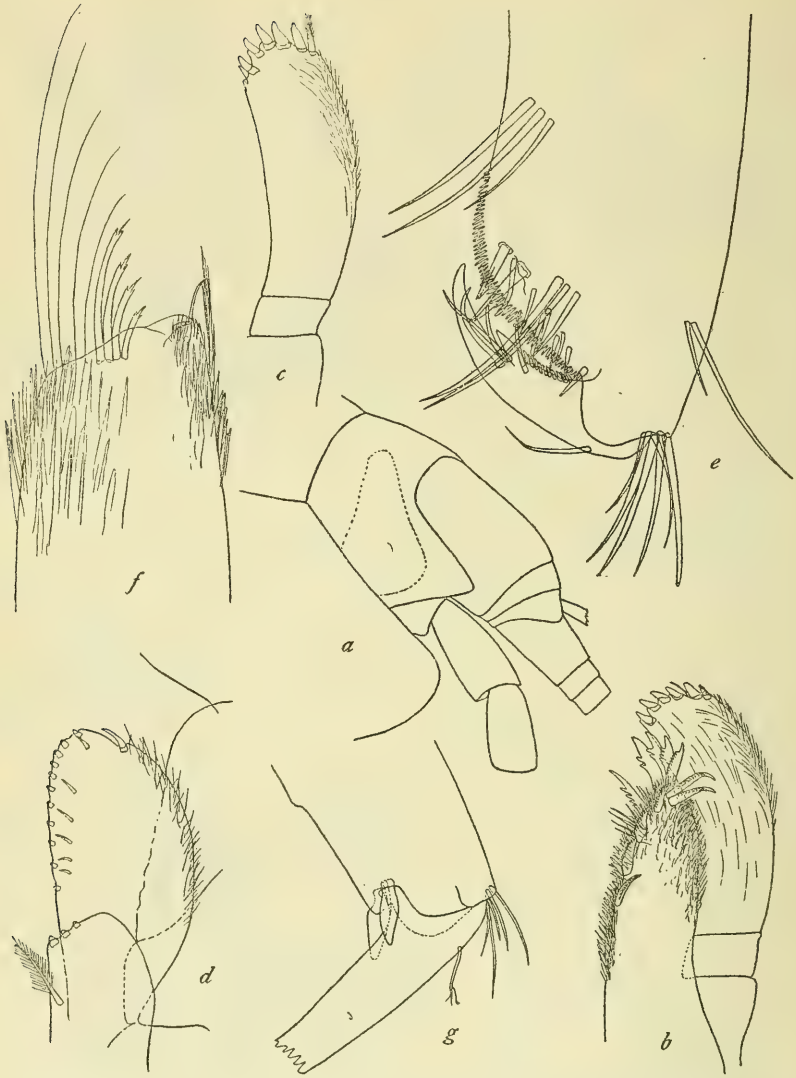

FIGURE 5.—ONISIMUS PLAUTUS. *a*, HEAD; *b*, MAXILLA 1, ENLARGED, SHOWING END OF OUTER PLATE AND PALP; *c*, PALP OF MAXILLA 1; *d*, INNER AND OUTER PLATES OF MAXILLIPED, ENLARGED; *e*, END OF GNATHOPOD 1, ENLARGED; *f*, END OF GNATHOPOD 2, ENLARGED; *g*, END OF PERAEOPOD 2, ENLARGED

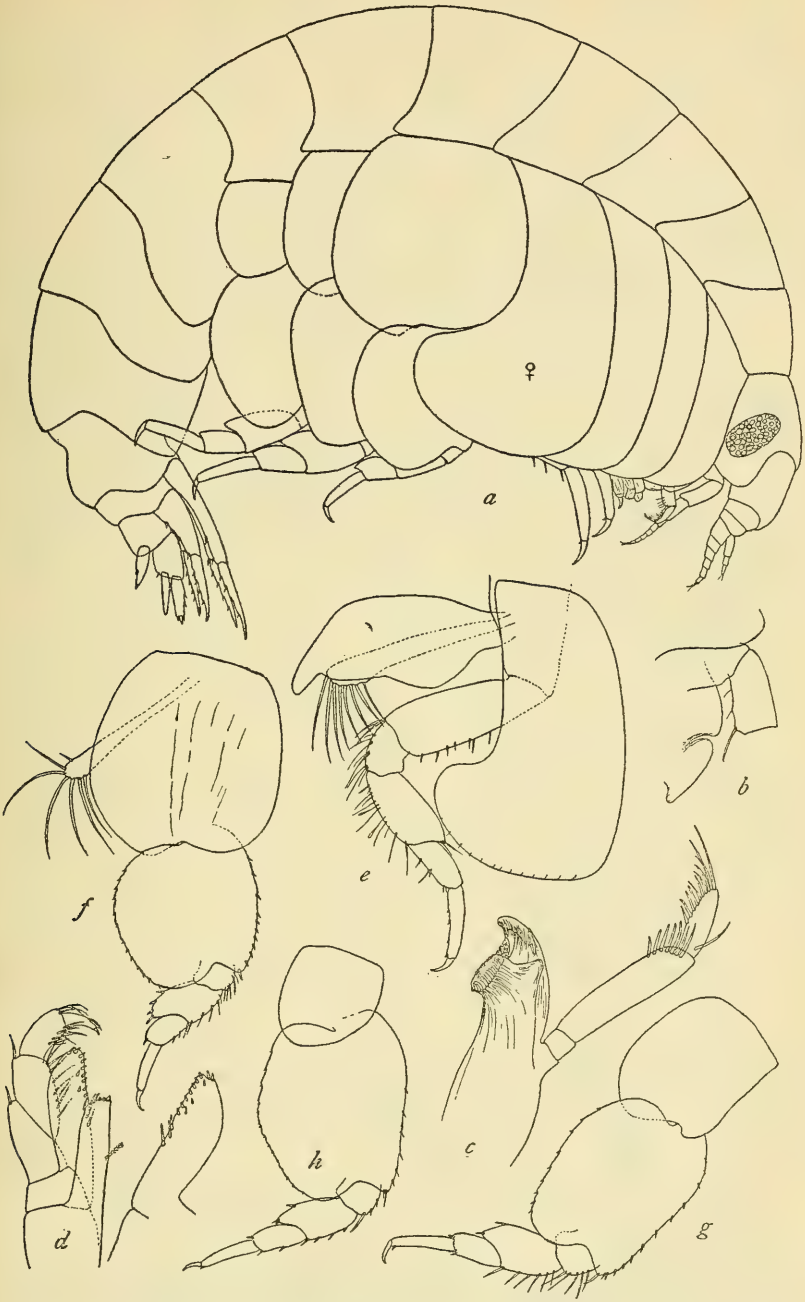

FIGURE 6.—ORCHOMENE DEPRESSA. *a*, ENTIRE ANIMAL, FEMALE; *b*, EPISTOME AND UPPER LIP; *c*, RIGHT MANDIBLE; *d*, MAXILLIPEDS; *e*, PERAEOPOD 2; *f*, PERAEOPOD 3; *g*, PERAEOPOD 4; *h*, PERAEOPOD 5

FIGURE 7.—ORCHOMENE DEPRESSA. *a*, END OF OUTER PLATE OF MAXILLA 1, ENLARGED; *b*, GNATHOPOD 1; *c*, END OF GNATHOPOD 1, ENLARGED; *d*, GNATHOPOD 2; *e*, END OF GNATHOPOD 2, ENLARGED; *f*, UROPOD 3; *g*, TELSON

with nine stout serrate spine-teeth, palp normal. Maxilla 2 normal. Maxillipeds, inner plate bearing three low teeth and a few spines on truncated end, outer plate narrow, reaching end of second joint of palp, bearing seven minute teeth on inner edge and two at the rounding apex, palp short, fourth joint bearing a minute nail with a seta on outer edge just beyond the center. First four side plates much deeper than their segments, first not expanded below and with lower anterior corner broadly rounding. Gnathopod 1, second joint rather stout, fifth and sixth subequal in length, fifth with lobe broad and very slightly produced, sixth slightly narrowing distally, palm transverse, defined by small tooth, slightly convex and finely dentate throughout, seventh joint stout, curved to fit palm and not overlapping. Gnathopod 2, sixth joint not quite two-thirds the length of fifth, palm slightly produced. Peraeopods 1 and 2 subequal in length and normal. Side plate 4 deeply excavate with posterior lobe broadly rounding. Peraeopod 3, side plate much deeper than second joint, which is broadly expanded, fourth joint broadly expanded. Peraeopod 4 longer than 3 or 5, side plate not as wide or as deep as second joint, which is not so greatly expanded as that of peraeopods 3 or 5, fourth joint not greatly expanded. Peraeopod 5, second joint much deeper than side plate and greatly expanded, fourth joint little expanded. Pleon segment 3 with postero-lateral margin slightly convex, postero-lateral angle very narrowly rounded but not produced. Pleon segment 4 with shallow sinus followed by a low, rounding, dorsal process. Uropod 1 projecting farther back than 2 or 3 which extend back equally. Uropod 3, outer ramus slightly longer than peduncle, inner ramus about as long as first joint of outer ramus and equaling it in width. Telson reaching back slightly beyond peduncle of uropod 3, divided nearly to center, lobes only slightly gaping, rounding apically, and each bearing a terminal spinule, a single spinule about the center of either lateral margin.

Length.—8 mm.

Type.—Cat. No. 62727, U.S.N.M., Bay of Fundy, taken by the U. S. Fish Commission in 1872. Two other specimens are in the lot from which the type was taken, and another lot of seven specimens bears the same locality label, Bay of Fundy, U. S. Fish Commission, 1872.

ORCHOMENE MACROSERRATA, new species

Description.—Female.—Head, lateral angles prominent with apices rather broadly rounding, eyes pear-shaped, black. Antenna 1 with four to nine joints in flagellum, accessory flagellum with four or five joints. Antenna 2, flagellum about as long as fourth and fifth joints

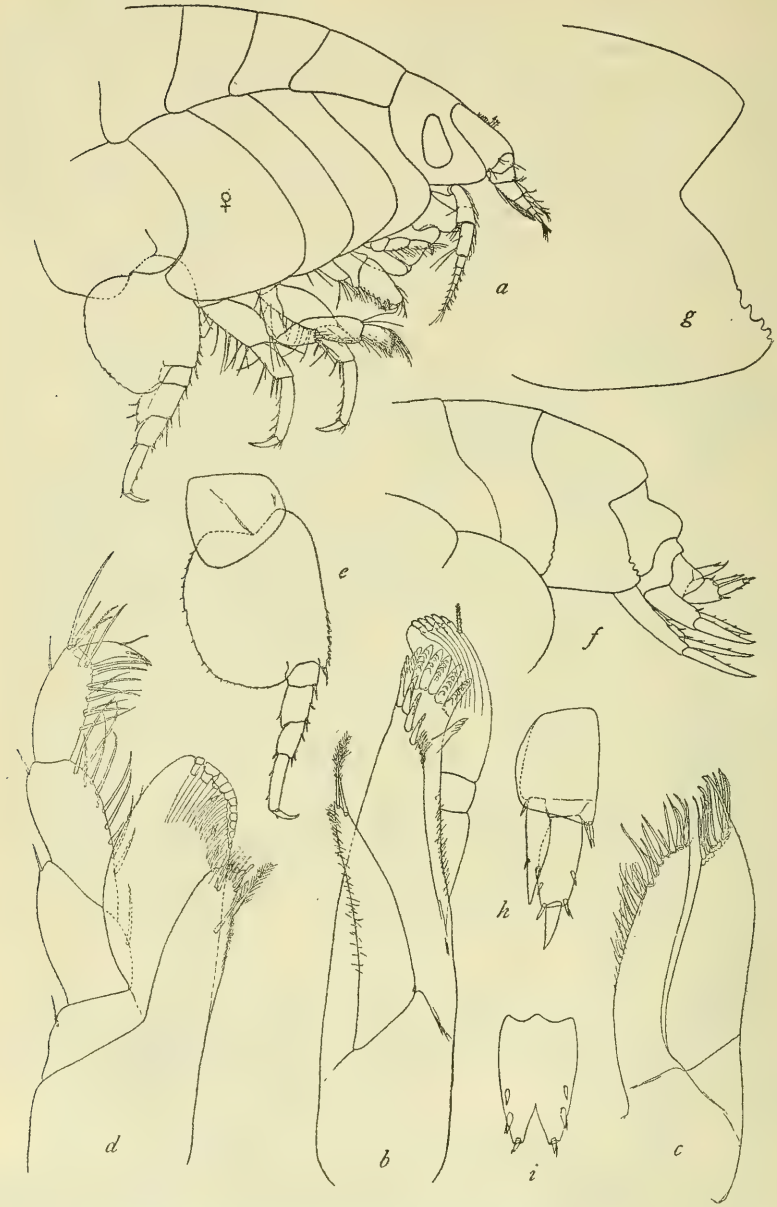

FIGURE 8.—ORCHOMENE MACROSERRATA. *a*, FRONT HALF OF ANIMAL, FEMALE; *b*, MAXILLA 1; *c*, MAXILLA 2; *d*, MAXILLIPED; *e*, PERAEOPOD 5; *f*, PLEON SEGMENTS 1–6, TELSON, AND UROPODS; *g*, PLEON SEGMENT 3, ENLARGED; *h*, UROPOD 3; MALE, TELSON

FIGURE 9.—ORCHOMENE MACROSERRATA. *a*, HEAD AND EPISTOME; *b*, RIGHT MANDIBLE; *c*, LOWER LIP; *d*, END OF GNATHOPOD 1, ENLARGED; *e*, END OF GNATHOPOD 2, ENLARGED

of peduncle together and composed of about seven joints. Epistome linguiform, projecting very prominently beyond the upper lip. Mandible about as shown by Sars for *O. batei*[2]. Maxilla 1, outer plate with 11 serrate spine-teeth. Maxilla 2, outer plate broader than inner. Maxilliped, inner plate reaching to end of first joint of palp and bearing three apical teeth, outer plate broad, reaching end of second joint of palp, armed on upper inner edge with a row of low flat teeth and on the under surface with four short spines and on the inner edge with two longer spines. Lower lip about normal, but outer edges somewhat constricted. Gnathopod 1, fifth joint shorter than sixth, lower margin produced into a narrow forward pointing lobe, sixth joint narrowing distally and about twice as long as its greatest width, palm slightly convex, crenulate, and defined by two stout spines, one on the outer and the other on the inner surface of the joint, dactyl slightly overlapping palm, bearing a single tooth on inner edge and several setae near apex. Gnathopod 2, fifth joint nearly twice as long as sixth, under broadly lobed surface bearing many short forward-pointing spinules or scales, sixth joint twice as long as wide, minutely produced, but not so strongly as is shown by Sars for *O. batei*. Peraeopods 1 and 2 normal. Peraeopod 3, second and fourth joints greatly expanded. Peraeopod 4 possibly slightly longer than 5, second joint not so much expanded as in peraeopod 3, fourth joint less expanded than in 3, but slightly more than in 5. Peraeopod 5 second joint more expanded than in 4. Pleon segment 3 with lower portion of postero-lateral margin bearing about four coarse teeth, second pleon segment bearing a few much shallower teeth. Pleon segment 4 bearing rounding dorsal process. Uropod 1 projecting backward slightly farther than 2 or 3, which project equally. Telson cleft about one-third of its length with lobes gaping.

Length.—Largest specimens measure about 8 mm.

Type.—Cat. No. 35774, U. S. N. M., Bay of Fundy, taken by the U. S. Fish Commission in 1872. Original number 552.

Other specimens in the Museum collection are as follows:

Bay of Fundy, U. S. Fish Commission, 1872. Original number 309, 3 specimens; original number 321, 4 specimens; original number 407, 4 specimens; original number 410, 1 specimen; original number 454, 8 specimens; original number 552, 2 specimens (Paratypes); no original number, 13 specimens.

All the specimens were taken by the U. S. Fish Commission in 1872 in the Bay of Fundy, in the vicinity of Grand Manan.

This species appears to be most closely related to *O. tschernyscheri* Brüggen from Jugor Strait, but in the present species the lobe of

[2] Sars, Crustacea of Norway, vol. 1, pl. 22, fig. *m*.

the fifth joint of gnathopod 1 is not so long, and the serrations on the postero-lateral margin of pleon segment 3 are much fewer in number and much coarser.

ORCHOMENELLA GROENLANDICA (Hansen)

1887. *Anonyx groenlandicus* HANSEN, Vid. Meddel. Naturh. Foren., Kjøbh., ser. 4, vol. 9, p. 72, pl. 2, fig. 5–5*g*.

Bay of Fundy, U. S. Fish Commission, 1872; 65 specimens.

Station 2699 steamer *Albatross*, south of Newfoundland, 45° 04′ 00″ N., 55° 23′ 00″ W., August 22, 1886, 72 fathoms, coral; 2 specimens.

ORCHOMENELLA MINUTA (Kröyer)

1846. *Anonyx minutus* KRÖYER, Naturh. Tidsskr., ser. 2, vol. 2, p. 23.

Bay of Fundy, U. S. Fish Commission, 1872; 1 specimen.

Location 101 steamer *Spedwell*, off Halifax, Sambro Light, W. by N. ¼ N. 9 miles, September 15, 1877, 42 fathoms, fine sand with *Ophioglypha;* 3 specimens.

Location 112–118 steamer *Speedwell*, Chebucto Head Light NW. by W. about 8½ miles, September 24, 1877, 52 fathoms, fine sand and mud; 10 specimens.

Grand Manan, August–September, 1898, Mary J. Rathbun; 1 specimen.

Station 2504 steamer *Albatross*, south of Nova Scotia, 44° 23′ 00″ N., 61° 22′ 45″ W., July 7, 1885, 82 fathoms, black mud and gravel; 2 specimens.

Station 2511 steamer *Albatross*, south of Nova Scotia, 44° 05′ 30″ N., 63° 31′ 30″ W., July 11, 1885, 84 fathoms, brown mud; 1 specimen.

Station 2463 steamer *Albatross*, southeast of Newfoundland, 45° 44′ 00″ N., 54° 27′ 00″ W., July 3, 1885, 45 fathoms, broken shell; 1 specimen.

Station 2497 steamer *Albatross*, east of Nova Scotia, 45° 04′ 00″ N., 59° 36′ 45″ W., July 6, 1885, 57 fathoms, yellow sand, broken shells, hard; 3 specimens.

ORCHOMENELLA PINGUIS (Boeck)

1861. *Anonyx pinguis* BOECK, Forh. Skandinav. Naturf., vol. 8, p. 642.

Bay of Fundy, U. S. Fish Commission, 1872; 20 specimens.

St. Johns, Newfoundland, June 29, 1885, steamer *Albatross*, low water; 3 specimens.

St. Andrews, New Brunswick (from lobster traps), taken by the Canadian Atlantic Biological Station; 10 specimens.

PARATRYPHOSITES ABYSSI (Goës)

1866. *Lysianassa abyssi* Goës, Öfv. Vet.-Akad. Forh., vol. 22, p. 519, pl. 37, fig. 5.

Station 2497 steamer *Albatross*, east of Nova Scotia, 45° 04′ 00″ N., 59° 36′ 45″ W., July 6, 1885, 57 fathoms, yellow sand, broken shells, hard; 1 specimen.

SOCARNES BIDENTICULATUS (Bate)

1858. *Lysianassa bidenticulatus* Bate, Ann. Mag. Nat. Hist., ser. 3, vol. 1, p. 362.

Station 2466 steamer *Albatross*, south of Newfoundland, 45° 29′ 00″ N., 55° 24′ 00″ W., July 3, 1885, 67 fathoms, coral; 4 specimens.

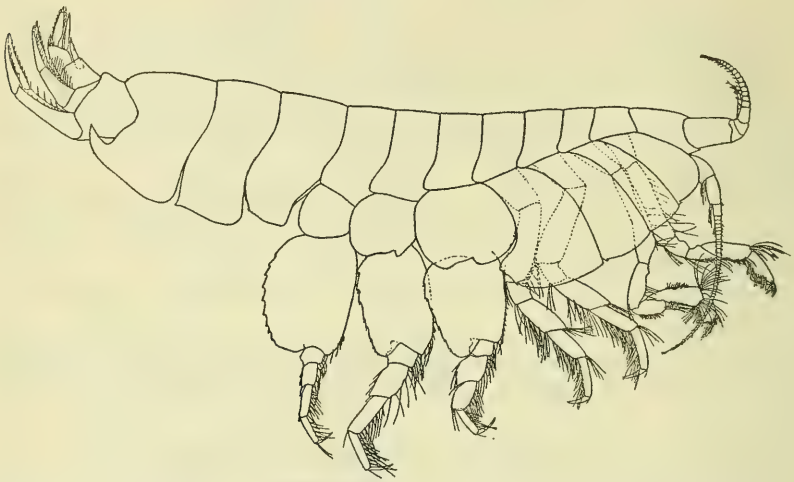

Figure 10.—Paratryphosites abyssi. Entire animal, male

TMETONYX GULOSUS (Kröyer)

1845. *Anonyx gulosus* Kröyer, Naturh. Tidsskr., ser. 2, vol. 1, p. 611.

Location 70 steamer *Speedwell*, about 120 miles south of Halifax, September 1, 1877, 190 fathoms, gravel and pebbles; 1 specimen.

Grand Bank, 1879 (19), Osburn; 2 specimens.

Station 2463 steamer *Albatross*, south of Newfoundland, 45° 44′ 00″ N., 54° 27′ 00″ W., July 3, 1885, 45 fathoms, broken shells; 1 specimen.

Station 2466 steamer *Albatross*, east of Nova Scotia, 45° 29′ 00″ N., 55° 24′ 00″ W., July 3, 1885, 67 fathoms, coral; 1 specimen.

Station 2485 steamer *Albatross*, east of Nova Scotia, 44° 24′ 00″ N., 57° 09′ 50″ W., July 5, 1885, 205 fathoms, fine white sand; 1 specimen.

Station 2491 steamer *Albatross*, east of Nova Scotia, 45° 24′ 30″ N., 58° 35′ 15″ W., July 6, 1885, 59 fathoms, white sand; 2 specimens.

Station 2497 steamer *Albatross*, east of Nova Scotia, 45° 04′ 00″ N., 59° 36′ 45″ W., July 6, 1885, 57 fathoms, yellow sand, broken shells, hard; 2 specimens.

Station 2703 steamer *Albatross*, south of Nova Scotia, 44° 01′ 00″ N., 59° 02′ 30″ W., August 23, 1886, 140 fathoms, gray sand and black specks; 1 specimen.

TMETONYX NOBILIS (Stimpson)

1853. *Anonyx nobilis* STIMPSON, Smithsonian Contrib., vol. 6, no. 5, p. 50.
1918. *Tmetonyx quadratus* KUNKEL, State of Connecticut Geol. and Nat. Hist. Survey, Bull. 26, p. 55, fig. 6.

Bay of Fundy, U. S. Fish Commission, 1872; 35 specimens.

Grand Manan, Long Beach, August 16, 1898, Mary J. Rathbun; 9 specimens.

St. Andrews, New Brunswick, in clean sand at half tide level just below surface on slope to Greenaway Island, on side farthest from Canadian Atlantic Biological Station, July 2, 1923; 2 specimens.

On July 23, 1928, James O. Maloney took a fine specimen near the mouth of the Matamek River, north shore of the Gulf of St. Lawrence.

TRYPHOSA COMPRESSA G. O. Sars

1891 and 1895. *Tryphosa compressa* G. O. SARS, Crust. Norway, vol. 1, p. 76; p. 685, pl. 4, fig. 2.

Banquereau, U. S. Fish Commission, September 13, 1878; 1 specimen.

Off Nova Scotia, steamer *Albatross*, July, 1885; 1 specimen.

URISTES UMBONATUS (G. O. Sars)

1882. *Ichnopus umbonatus* G. O. SARS, Forh. Vid. Selsk., Christiania, no. 18, p. 79, pl. 3, fig. 2.

Station 2484 steamer *Albatross*, east of Nova Scotia, 44° 20′ 00″ N., 57° 11′ 15″ W., July 5, 1885, 204 fathoms, fine white sand; 2 specimens.

U. S. GOVERNMENT PRINTING OFFICE: 1930

THE EXCAVATION AND REPAIR OF BETATAKIN

By Neil Merton Judd

Curator of American Archeology, United States National Museum

INTRODUCTION

The Indian appropriation act approved May 18, 1916, included the following:

> For preservation and repair of prehistoric pueblo ruins and cliff-dwellings, under the supervision of the Smithsonian Institution, Navajo National Monument, Arizona, $3,000.

To carry out the provisions of this item the present writer was rather unexpectedly designated, early in March, 1917, representative of the Smithsonian Institution and special disbursing officer, Bureau of Indian Affairs. Availability of the appropriation was limited to the then current fiscal year, ending June 30.

Entraining at Washington March 16 I proceeded to Flagstaff, Ariz., engaged four laborers, and left with them by automobile on March 20 for Tuba; thence by 4-mule team to Kayenta; thence by saddle horses and pack mules to Betatakin ruin. This journey of approximately 200 miles from the railroad was not without its disagreeable features.

Navajo National Monument, at an elevation of 7,000 feet, is none too inviting in early springtime when sandstorms crowd the heels of retreating winter. We turned northward from Tuba into the face of wind-driven snow, camped about 6 miles short of Red Lake at some deserted Navajo hogans whose old timbers offered fuel and partial protection, spent the next night under frost-covered blankets in the open desert, and arrived at Kayenta March 24, just as a setting sun was painting the neighboring sandstone buttes with brilliant crimson.

My diary recalls the succession of discouragements under which our special task was pursued. Both economic and climatic obstacles intervened. We broke trail through snow 2 feet deep to establish

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camp at Betatakin, March 27; once there, each night brought freezing temperatures until May 1 and occasionally thereafter; rain, hail, and snow fell with annoying frequency. All this, so our irregular Navajo boarder insisted, was owing to the fact that our work in the ruin disturbed the spirits of the ancient people. But I am reminded that our last snowstorm occurred May 31; that ice covered our water pails on the morning of June 2. I am reminded, too, of our meager rations.

Foodstuffs were at a premium; trading-post stores were practically exhausted. Wool continued in demand and the Navajo, childishly prodigal in time of plenty, had bought freely. Having received twice the customary price for their last clip, the Indians still had credit to draw upon; native jewelry to pawn. None cared to work; winter lingered. Lacking forage, Indian ponies were poor; roads were ribbons of knee-deep mud; the wet-weather rate of $2.50 for each hundredweight from Gallup to Kayenta did not tempt freighters. In consequence, even the usual modest fare of desert travelers was unprocurable. If we had flour there were no beans; if beans, no flour. For days at a time, and repeatedly, rice formed our sole diet. The Navajo would willingly sell neither sheep nor goats. We substituted "Brigham tea" when coffee could not be had. At times, and in their own convincing way, my workmen expressed a measure of discontent.

Then, late in April, came news of United States entry into the World War. My three remaining assistants, impatient to be in the fray, promptly registered in their respective States. And just as promptly they were ordered into service by the too-zealous local draft board. Regulations governing distribution of foodstuffs had been imposed; reservation traders could not replenish their empty shelves. Nevertheless, there remained the chance of forcing our assignment to conclusion.

Snow and lack of forage made it impossible to keep a saddle horse at camp; hence, on three separate occasions, it was necessary to walk the 20 miles to Kayenta seeking supplies. I happened to be there April 29 and joined the trader in going to the relief of two Indian freighters, then stuck in the mud 10 miles out, who had been on the road from Flagstaff since late December. The few sacks of flour received at Kayenta on May 20 immediately sold at $10 a 100; the next lot arrived June 10, on 20 burros driven by Indians from near Farmington, N. Mex. Navajo National Monument seemed altogether isolated in the spring of 1917.

This recital is offered not as an apology for a task left unfinished but rather as evidence that factors quite beyond one's control sometimes arise to handicap the field worker. Those unforeseen condi-

tions we experienced might easily have forced early abandonment of our undertaking except for the cordial cooperation of Mr. and Mrs. John Wetherill and Mr. Clyde Colville, of Kayenta. To these good friends I make public acknowledgment of my appreciation, however tardily. As with other transients before and since, Mr. and Mrs. Wetherill welcomed me whole-heartedly into their hospitable home; drew generously from their family larder at times of urgent need, and persuaded reluctant Navajo into our service when my own efforts failed.

I have said our task was left unfinished. The special appropriation cited in the first paragraph above was intended to cover the major ruins of Navajo National Monument. There are three such—Betatakin, Keet Seel, and Inscription House. We concentrated upon the first of these. The work there accomplished will be apparent from the pages which follow. That left undone includes repair of the southwest house group and adjacent retaining wall; partial reconstruction of missing rooms whose former positions were plainly evidenced in the east half of the cave; basal wall repairs with cement and the placement of steel tie rods in certain dwellings, as originally contemplated. The cement and steel we ordered for this purpose from Gallup on April 2 were not delivered in Kayenta, so impassable were the muddy roads, until June 8—too late to be relayed to Betatakin and positioned.

Since the World War and return from military service I have constantly entertained the hope that additional funds might be provided with which to complete not only the work herein described but also that intended for Keet Seel and Inscription House. It now appears this hope is not soon to be realized. Fairness to those coworkers who have need for certain facts at my disposal urges presentation of our observations in Betatakin without further delay.

Of the sum designated in the act of May 18, 1916, more than one-third was returned to the Treasurer of the United States, as required by law. This refund and the fact that it was not humanly possible in 1917 to conclude the repairs contemplated by Congress, seemingly would justify a new Federal appropriation to insure preservation of the incomparable cliff dwellings of Navajo National Monument. Those ancient villages are not surpassed even by the marvelous ruins of Mesa Verde National Park, Colo., visited by nearly 17,000 persons in 1928; they stand as visible reminders of an enlightened, though primitive, people who played a most important part in the conquest of our arid Southwest centuries before European mariners dreamed of a New World; they merit restoration and protection as an irreplacable inheritance of our Nation from its prehistoric predecessors.

BETATAKIN AND THE KAYENTA DISTRICT

Betatakin occupies a large cave in the north wall of an unnamed south fork of Laguna Canyon,[1] which latter empties into Tyende Creek at Marsh Pass. (Pl. 2.) About 15 miles northeast of the Pass is Kayenta,[2] founded by Wetherill and Colville as a trading post late in 1909 and since grown into an oasis of peculiar charm—the home of several white families, chiefly associated with the local Navajo Indian hospital and its related activities.

To archeologists an indefinitely bordered area surrounding this settlement is known as the "Kayenta district." Its rugged canyons were anciently inhabited by a semisedentary people whose evolving culture has been clearly portrayed by Kidder and Guernsey.[3] Following the so-called Basket Makers, first known agriculturists of the Southwest, came three other equally distinct stages of tribal and material development to culminate in those great, communal towns of the Pueblo III[4] period—Betatakin, Keet Seel, and Inscription House.

Throughout the centuries required for this perfectly obvious sequence of cultures and with a vigor that increased as each generation passed, established villages in the Kayenta district were recurrently attacked by more warlike, nomadic peoples. The identity of these wandering hunters remains undetermined but the fact of their former presence as disturbers of tranquil community life is evidenced here, as in other parts of the Pueblo area.

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[1] So named from the ponds that formerly marked its middle course. Gregory (1916, p. 48) says: "At the time the topographic map was made (1883) Laguna Canyon held a number of lakes which have since disappeared in consequence of recent deep trenching of the alluvial fill."

Throughout the Kayenta district in 1908 and 1909, that which Gregory designates "Laguna Canyon" was widely known as the Segi; that which he names "Tyende Creek," running from Marsh Pass to the Rio San Juan, was commonly called Laguna Creek. Pools were then present in the open valley south of Tyende Mesa; Segi Canyon was already deeply trenched, but its arroyo banks clearly showed the stratified deposits formerly laid down in placid ponds. Segi Canyon is the To-wan-aho-che Creek of the General Land Office map of 1887; the To-wan-on-Cheo Creek of the presidential proclamation dated March 20, 1909, and hereinafter mentioned. "Tyende Creek" is obviously an erroneous recording of "Kayenta Creek."

[2] Individuals will naturally differ in attempting to record, with English characters, the pronunciation of Indian place names. For example, *Kaenti* is the spelling first used by Cummings (1910); *Kayenta,* that subsequently employed by the same writer, by other explorers and by Federal cartographers. *Segi* Canyon (Gregory, 1916) has been published both as *Sagi* (Cummings, 1910; Kidder and Guernsey, 1919, 1921) and *Sagie* (Cummings, 1915; Judd, 1918). *Keet Seel* (Gregory, 1916; presidential proclamation of March 14, 1912) has been printed *Kitsil* (Cummings, 1910), *Kitsiel* (Fewkes, 1911), and *Kietsiel* (Kidder, 1924). Because of these and other possible variants it seems not improbable that the orthography employed by Gregory (1916) in his comprehensive study of the Navajo country will be adopted by most observers henceforth reporting upon the divers interests of this fascinating region.

[3] 1921; 1921*a*. See also Kidder and Guernsey, 1919; Kidder, 1924.

[4] A designation now accepted by most students of Pueblo archeology. See Kidder, 1927.

In describing the procession of prehistoric civilizations through the Kayenta district, Kidder[5] writes: "* * * it seems likely from the finds of their typical pottery at Pueblo Bonito and Cliff Palace that the proto-Kayenta villages were inhabited at the same time as the great dwellings of the Mesa Verde and Chaco Canyon; and that the late Kayenta sites were erected after the Mesa Verde and Chaco Canyon had been abandoned. Thus Kitsiel and Betatakin may well have been the last large communities that existed in the San Juan drainage." Cummings[6] had previously drawn a similar inference; more recently, his and Kidder's deductions have been fully confirmed by the as yet unpublished explorations of the National Geographic Society at Pueblo Bonito, under direction of the present writer, and by the related "tree-ring" chronology now being erected by Dr. A. E. Douglass, of the University of Arizona.

But herein we are concerned solely with the excavation and repair of Betatakin. No comparison is to be drawn between it and other ruins of the Kayenta district or elsewhere; no effort will be made to determine the place occupied by Betatakin on the ladder of Pueblo history. The present paper serves merely to present certain observations resulting from our 1917 expedition, as an aid to that more intimate study of the village yet to be written.

Although Betatakin is now a familiar name to most students of Pueblo archeology, few are aware that it was first seen by whites on August 5, 1909, when a Utah University exploring party led by Prof. Byron Cummings and guided by John Wetherill was directed to it by a Navajo Indian, casually met in Segi Canyon. This Indian pointed the way and then sat down beside the trail to await the party's return. Through inherent fear of all things associated with the dead, he steadfastly refused to advance within sight of the ruin. The Kayenta district was wild and untamed at that time; canyons to the westward sheltered many young Indians who had yet to see their first white man, unbelievable though this may seem.[7] Archeological explorers looked like prospectors; buttes in Monument Valley bore the names of men killed while seeking minerals on the reservation in open defiance of Navajo wishes. At Oljeto, Wetherill and Colville maintained the only trading post between Bluff and Tuba.

As student assistant to Doctor Cummings I participated in the brief, initial inspection of Betatakin, but I was not present in the

[5] 1924, p. 73.

[6] 1915, p. 278.

[7] In August, 1909, while guiding W. B. Douglass from Rainbow Bridge to Keet Seel and Betatakin, the present writer witnessed inauguration of a 3-day war ceremony, surreptitiously held near the head of Piute Canyon; a few days later, in Oljeto, he was informed by old Hoskinnini, revered chief of the northern Navajos, that the Douglass party were the first whites ever seen by several Indians, in their mid twenties, attending that ceremony.

autumn of 1909 when the professor, following explorations which resulted in his discovery of important cliff dwellings south of Navajo Mountain [8] and that marvel of erosion, the Rainbow Natural Bridge,[9] returned to resume, and conclude, his investigation of this remarkable ruin.[10]

Government reservation of Betatakin, Keet Seel, and Inscription House came about in this wise: While at Bluff, Utah, in September, 1908, W. B. Douglass, examiner of surveys for the United States General Land Office, learned from Professor Cummings's guide, John Wetherill, and immediately reported to Washington, the existence of certain "fine prehistoric ruins about 90 miles west of Bluff." Douglass asked and received instructions to locate and examine these ruins. It is not to his discredit that he failed in this quest, even when aided by trail maps furnished by Mr. Wetherill and his partner, Clyde Colville. The information so gained enabled the surveyor to submit, March 8, 1909, the data on which was based the all-inclusive presidential proclamation dated 12 days later creating the Navajo National Monument. It was in mid August, 1909, and at Doctor Cummings's direction, that I accompanied Mr. Douglass from Rainbow Natural Bridge to Keet Seel and pointed out, as we passed it, the south fork in which Betatakin is located. As Douglass's earlier and somewhat presumptuous communications to Washington prompted the initial visit and preliminary report of Dr. J. W. Fewkes,[11] so did Douglass's surveys of August–November, 1909, supply the awaited details incorporated in the second presidential proclamation of March 14, 1912, which superseded that of March 20, 1909, and reduced the monument to its present area.

Although he merely anticipated Professor Cummings in so doing, to W. B. Douglass is owing such honor as may be for having first apprised the General Land Office of the existence of important prehistoric ruins west of Bluff and for having urged their reservation and protection in the public interest. Likewise to Professor Cummings is due credit for having first recommended a Federal appropriation to insure repair and preservation of the major Segi Canyon ruins. Senator Reed Smoot, of Utah, had introduced such a bill in 1915; secured its passage during the next session of Congress. Under date of July 15, 1916, Special Agent W. J. Lewis reported to the General Land Office highly approving the investigations of Doctor Cummings and earnestly recommending that he be placed in

[8] Cummings, 1910.

[9] Cummings, 1910*a*; Judd, 1927.

[10] Few realize so fully as the present writer that only ceaseless pressure of academic responsibilities has so long, and so unfortunately, delayed publication of Doctor Cumming's archeological observations. As pioneer archeologist of the Kayenta district he has accumulated a fund of information eagerly awaited by his younger coworkers.

[11] 1911.

charge of the reconstruction contemplated within the new monument. This recommendation would have been followed gladly since Professor Cummings, the first archeologist to examine the prehistoric villages in question, was logically the one to restore them. But the law required that Federal funds be disbursed only by a Federal employee. Thus it came about that the present writer, a member of the Smithsonian staff, was assigned the task of carrying out the provisions of the act of May 18, 1916.

It was westward bound that I determined to restrict my efforts to Betatakin. Based on personal knowledge of the Kayenta district, this decision seemed wise for three reasons, previously mentioned:[12] (1) More than one ruin could not be excavated and restored in the time available, from the sum appropriated; (2) Betatakin was, perhaps, in greatest need of repair; (3) the site was more accessible than the others and furnished abundant water for camp purposes.

When our animals were unpacked at Betatakin on the afternoon of March 27, 1917, we first cleared away the snow and improvised sleeping quarters under the scrub oaks that border a little flat near the gurgling stream. Firewood was close at hand, but our thin, cotton tents afforded scant protection from the wintry blasts that played almost incessantly up or down the canyon. During the weeks which followed we frequently retired to the old dwellings in the cliff there to seek shelter from the storms.

Our work began with a cursory examination of the talus immediately below the village. Neither house remains nor burials were disclosed there; stratified deposits from which length of occupancy and local changes in the technique of pottery manufacture might be gauged were utterly lacking. The inhabitants of Betatakin amassed no single trash pile—the delight of dirt archeologists—but utilized their household débris in widening the rock terraces of the cave, thus to increase its habitable space.

During the centuries which followed abandonment of the pueblo, walls had collapsed; tons of wind-blown sand had lodged in the empty rooms and the courts between. In such accumulations, watered by seepage, long banks of columbine and intertwining box elders and scrub oaks had taken root. Huge blocks of sandstone had broken from the cave roof to crush the eastern house group. Most of the ancient dwellings had been previously excavated and refilled to protect the fractured masonry. All this vast quantity of sand, rock, and overturned rubbish must necessarily be cleared away before our principal task could properly begin.

This task, let me repeat, was solely one of repair and preservation. Betatakin had been thoroughly explored by Professor Cummings

[12] Judd, 1918.

in 1909; its story, in so far as this could be read from the remains, had been patiently recorded. Ours was the work of mending broken and insecure walls; of patching roofs; of providing ladders to facilitate access by those less agile than primitive folk. In the period between 1909 and 1917 the Kayenta district had become a veritable magnet attracting, in ever increasing numbers, persons who value solitude and weird desert beauty.

While fulfilling our mission at Betatakin we sought also to preserve the prehistoric atmosphere of the place; to so disguise our own handiwork that it would be unobtrusive thereafter. During our clearing operations we noticed that some of the old mud mortar had outlasted the friable sandstone it bound together. After brief experiment we were able to duplicate this mortar with a half-and-half mixture of clean sand and the compact red clay that occurs in relatively thin layers beneath the massive Jurassic sandstone of the cliffs. Stones and timbers from shattered dwellings were salvaged and reused. In repairing or reconstructing house walls we took pains to eliminate the marks of our tools; at the same time, we deliberately broke joints in our stonework, a precaution with which the ancient masons did not concern themselves. This slight difference in method will, in most instances, serve to identify the walls we built. While nearly every room received some measure of attention, the notes which follow will guide future students to our major repairs.

NOTES ON BETATAKIN ROOMS.

As Plate 10 of his "Preliminary report on a visit to the Navaho National Monument," Doctor Fewkes (1911) publishes a ground plan of Betatakin prepared by W. B. Douglass. This plan I naturally assumed to be correct; it forms the basis of that which appears herein as Plate 3.[13] House numbers previously assigned are retained in each instance, but since these end with room 96 those additional dwellings disclosed in 1917 have been designated rooms 100–135. Perhaps a dozen others, evidenced by characteristic wall seatings, might have been included had we found opportunity carefully to examine and delineate their respective sites.

The notes which now follow were made during the course of our excavations. Room measurements taken at the same time will be found in the table beginning on page 72.

Room 1, above and west of room 2 in the extreme western end of the cave, was obviously designed for storage. Its floor is the rough,

[13] Although without instruments of precision, we observed certain minor discrepancies in the Douglass survey. This, it should be borne in mind, was made under pressure of time and before all the house walls were exposed. The principal differences between his plan and ours will be manifested by direct comparison of the two and by our description of the individual rooms.

unworked cliff, slightly filled in at the front. Three ceiling beams, extending from the front wall to a masonry fill at the rear, support short cross poles and a thick layer of willows, covered directly by adobe. Two poles overlain with split cedar so parallel the front wall as to suggest a former hatchway in the north corner. Three pegs for hanging articles protrude from the inner front wall.

A 16 by 25 inch (0.40 by 0.64 m.) door opens through the northeast wall. Its sill, widened outside by a sandstone slab on edge, formerly supported a stone door which fitted into grooves on the outer jambs and was held firmly in place by wooden wedges inserted through feather-cord loops. One such loop occupies a hole at each side of the door; that on the north is held in place by mud. At the outer southeast side a bench 5 by 12 inches (0.13 by 0.31 m.) by 11 inches (0.27 m.) high fills a narrow crack.

Through the lower front wall four roof poles protrude from room 2. This latter structure was obviously built first, for there is a distinct line of separation between the large blocks forming its rear wall and the smaller stones in the front wall of room 1.

We attempted no repairs in rooms 1–8; nor on the masonry of court 10.

Room 2 was probably a storeroom; no smoke stains appear on its walls. It floor is mostly of fairly level, native rock, but a shallow fill in front concealed several east-west poles horizontally embedded about 6 inches (0.15 m.) above the base of the east wall. These were undoubtedly deemed necessary as supports or anchors, since the masonry stands flush with the cliff edge. Two pegs protrude from the southeast wall; two beams extend through from room 3. Six beams support the ceiling of willows, cedar bark, and adobe mud; in the northeast corner of this is a hatchway, the only entrance.

Five feet six inches above the outer southeast corner of the roof are two holes, drilled through a cliff angle; near by is a similar, single eyelet. From these, various light objects were doubtless suspended by the ancient inhabitants.

Room 3, a dwelling, exhibits the smoke stains of long occupancy. The lower half of its three masonry walls was repeatedly plastered, but the west, or cliff, side was not similarly surfaced. Two small, parallel timbers next the cliff and a larger, central beam support 10 east-west ceiling poles carrying layers of willows, reeds, and mud. A small smoke vent through the middle roof, next the north wall, had been closed with cedar bark and plastered over. In the southeast corner the solid sandstone surface is about a foot lower than the remaining floor, which lies some 8 inches (0.20 m.) higher than that of room 4.

At the floor level an opening 11 inches (0.27 m.) square connects with room 4. Directly in front of this opening, embedded in the floor of room 3, is a willow loop—one of two loom anchors. The second is wanting, but directly above, two loops still hang from a ceiling cross pole. Four wall pegs remain in position; holes for four others may be noted.

A door opens through the north half of the east wall. Just within this door, and formerly protected by a now missing screen, is the fireplace. The retaining wall continuing from court 10 ends against the outer east wall, south of the door. Above its south jamb six shallow holes had been drilled.

On the cliff face above the roof a " sandal " figure had been pecked; pointed and flat implements had been sharpened and white paint crudely spread in several places. Above the southeast roof corner one may note portions of a pair of drilled holes on a broken cliff slab.

Room 4 adjoins room 3 on the north and is apparently of later construction. Its east wall is missing; of the north wall, a section at the northwest corner stands 3 feet (0.91 m.) high against the cliff. Above this fragment and formerly concealed by the wall are several holes, pecked through the cliff corner; two pairs of similar holes on the cliff face had been plastered over. Through the west end of the south wall, 8 inches (0.20 m.) above the floor, a 10 by 18 inch (0.25 by 0.46 m.) opening marks the position of a former room 3 door, the lintels of which still show through three coats of plaster.

In the middle floor is a slab-lined fireplace measuring 16 by 18 inches (0.40 by 0.46 m.); its deflector slab, standing on the east, suggests a former door on that side.

Room 5, beneath room 6, was used for storage. At least the smoke stains which ordinarily identify a dwelling are lacking. Vertical cliff forms its south and west walls, while the other two are of masonry, freely chinked. The floor, of native rock, is slightly higher than the terrace outside.

A single beam, paralleling the cliff, supports the ends of six cross poles; upon and at right angles to these are layers of willows and reeds. On the floor we found a cedar pole, slightly shorter than the room length, which may formerly have been an additional ceiling support, since its butt end fitted in a hole at the north side when the opposite end rested on a protruding rock between the main beam and the cliff. Through the middle east wall is a 15 by 24 inch (0.38 by 0.61 m.) door whose outer jambs are grooved for the usual slab. A loop fastener appears on the north side only. Four sticks support the sandstone lintel; in its stone sill are two grooves where axes were sharpened.

Fire stains on the cliff at the outer southeast corner mark the position of an open fireplace.

Room 6, above room 5, probably served also for storage. Its walls are unsmoked; its floor, smooth and hard. The cliff forms its south and west sides, while the other two are composed of small, irregular stones laid in quantities of adobe mud, chinked with sandstone spalls. The outer east wall, smooth and regular, is superior to most Betatakin masonry; the outer north wall is plastered. (Pl. 7, A.)

Paralleling the south cliff wall is a single large ceiling beam, the west end of which rests on a narrow wedge of masonry, built in a crevice. This south beam supports one end of a timber which parallels the west cliff, and the latter beam, in turn, supports the ends of 14 cross poles. Above these is a thick layer of willows with adobe mud spread directly upon it to complete the roof. Six central cross poles have been broken by rock falling from the overhanging cliff.

A door through the middle north wall measures 18 by 24 inches (0.46 by 0.61 m.). Its lintel includes four sticks and a large sandstone block; its sill is a well-worn slab showing two shallow grooves where axes were sharpened. This sill and both outer jambs are deeply grooved for the door slab characteristic of storerooms; on each side is a willow loop for wooden fasteners. An inset step, 7½ inches (0.19 m.) wide by 3 inches (0.076 m.) high by 2½ inches (0.063 m.) deep, lies in the outer north wall 19 inches (0.48 m.) below the door sill and 17 inches (0.43 m.) above the roof of room 7. A similar step, 4 by 1¾ by 2 inches, lies upon the lintel slab, 24 inches below the roof of room 6. The protruding end of the west beam doubtless served as an additional step.

Room 7, adjoining room 5 on the north, is a dwelling whose west wall is formed by the cliff. Its floor is mostly solid rock, but the east third was filled in to a depth of from 6 to 18 inches. Two north-south beams support a ceiling of 18 cross poles overlain with willows and cedar bark. One of the cross poles was spliced, its two portions being tied with yucca strips; three cross poles extend only from the central beam to the east wall. Of equal interest is the fact that the west beam, hewn off on top, was braced in the middle by a post resting on a sandstone block. A former hatchway, 3 feet 3 inches (0.99 m.) from the north wall, is evidenced by the cut ends of several cross poles showing in the broken roof of the southeast quarter.

Abutting the outer northeast corner of room 5 is a section of masonry, 20 inches (0.51 m.) wide, the perpendicular east end of which is slightly convex, carefully chinked with numerous spalls, and plastered over as though to form a door jamb. Similar treatment is noted for the upper south end of the broken east wall. Together,

these finished wall ends suggest for room 7 a southeast corner door extending from floor to ceiling. (Pl. 8, B.) Such an entrance would be most unusual; none like it is observed elsewhere in Betatakin nor, indeed, can I recall having seen one in any other prehistoric Pueblo village.

At the outer northwest corner, just below the roof level, a single step had been pecked in the cliff face.

Room 8 is merely a recessed platform, 20 inches wide by 6 feet long (0.51 by 1.82 m.), formed by a convex wall on a ledge above the northwest corner of room 7. (Pl. 7, A, B.) Externally this wall stands 26 inches high to the solid rock floor; there is no trace of upper wall masonry.

Room 9. The remains of a small storeroom opposite the northeast corner of room 7; outside of and below the retaining wall of court 10. It is shown but not numbered on Douglass's ground plan.

Court 10, long and narrow, lies between rooms 7 and 11; it is formed by the irregular retaining wall which extends from the south corner of room 11 to the east side of room 3. This wall appears not to have stood more than 1 foot above the court floor; the latter consists mostly of native rock, with a débris fill along the east side. Shallow, close-lying steps on the uneven rock surface next the cliff were probably pecked by children at play. Opposite the northeast corner of room 7 and fronting rooms 3 and 4 the retaining wall had largely disappeared prior to 1909; elsewhere it is still well preserved. At the northeast corner of room 4 the walk formed by this wall was extremely narrow.

Against the retaining wall and 5 feet 3 inches (1.6 m.) from room 11 is a fireplace measuring 20 by 34 by 12 inches deep (0.51 by 0.86 by 0.31 m.). In the east corner, with its sill at the court level, a 10 by 11 inch (0.25 by 0.27 m.) vent opens downward into room 11. Nearby, the fragment of a small post stands against the inclosing wall.

At the north end of court 10 a slender pine pole, 30–35 feet long, gave access to the gallery ledge above. (Pl. 26, A.) The ladder leading to the roof of room 11 is one we substituted for steps pecked in the cliff at the north corner.

Room 11 is one of the most interesting chambers in Betatakin, since it obviously is an old dwelling, remodeled for ceremonial purposes. Next the cliff wall is a ceiling beam whose west end rests on a shelf of masonry; two other beams, with butt ends opposite, lie side by side across the middle room. On these timbers are 25 cross poles, overlain by layers of willows, cedar bark, and sand. Where the cross poles were too short to reach from the southeast wall to the cliff two were placed together, butt ends opposite. The lower third of the southwest wall and the lower half of the southeast and northeast walls

were surfaced; traces of plaster also remain on the northwest, or cliff, side.

Incised drawings appear in the smoke-blackened plaster of all four walls. (Fig. 1.) On the north half of the southwest wall 22 parallel and approximately vertical lines varying in length from 1 to 4 inches have been scratched. Other scratches occur below this group, but no geometric design is distinguishable among them. So-called "pottery" or "basket" designs were incised in the plaster of the southeast wall.

A south corner roof opening, 17 by 29 inches (0.43 by 0.73 m.), had been cut through after completion of the ceiling and perhaps after conversion of the room. This hatchway, 8 inches from the southwest wall, was rimmed with slabs on all except the southeast side; its inner jambs, above the cross poles, were plastered with adobe and chinked with small spalls. Two feet from the west corner and 13 inches above the floor a former southwest door, 17 by 29 inches (0.43 by 0.73 m.), had been carefully blocked from the outside, leaving its inner sill exposed to form a shelf 5 inches wide.

In the south corner an opening, 12 inches (0.31 m.) high by 17 inches (0.43 m.) wide, formerly pierced the southeast wall at the floor level; its east jamb sloped to the west. Externally this ventilator was a full third less than its inner dimensions. Apparently it did not prove entirely satisfactory, for it had been closed with masonry from the inside and a second vent, 12 inches (0.31 m.) high by 11 inches (0.27 m.) wide, cut through the southwest wall flush with the south corner and 9 inches above the floor. The slab sill of this second opening slopes upward to the level of court 10. Within the room and directly below this latter vent are the remains of a shallow, basinlike depression, 16 inches (0.41 m.) in diameter by 1½ inches (0.038 m.) deep. Formerly a ladder extended through the hatchway directly above this depression. A slab fire screen, 24 inches (0.61 m.) wide by 25 inches (0.64 m.) high by 1⅜ inches (0.034 m.) thick, abuts the southeast wall 27 inches (0.69 m.) from the south corner. Eight inches east of this screen and 5 inches (0.13 m.) from the southeast wall is a fireplace whose dimensions average 16 by 18 by 7 inches deep (0.41 by 0.46 by 0.17 m.); it is lined and paved with slabs and its inner corners rounded with adobe. The ceiling willows above this fireplace had been plastered with mud—a simple, protective measure that might have been followed profitably by other prehistoric house builders.

Our repairs were confined largely to the southwest wall. In addition, we propped a cracked ceiling beam with a cedar post set on a sandstone slab; and placed, through the hatchway, a pole ladder fitted with oak rundles.

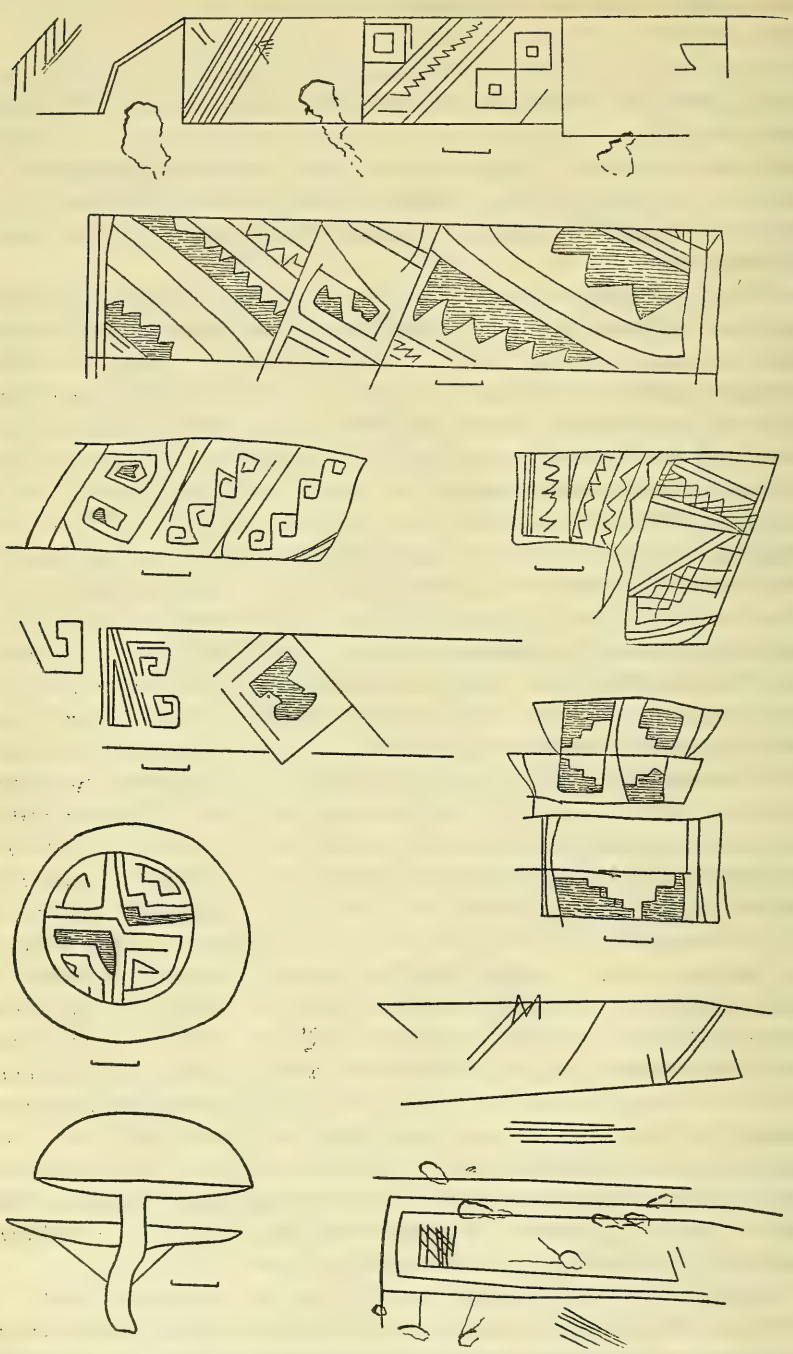


FIGURE 1.—INCISED FIGURES ON THE WALLS OF ROOM 11. (THE BAR REPRESENTS 1 INCH)

On the cliff above room 11 two holes, 1½ inches apart, had been drilled through a thin layer of sandstone.

Room 12 is a storeroom, built against the outer northeast wall of room 11. Its floor is the solid sandstone of the uppermost terrace; its masonry bears no trace of smoke. A single northeast-southwest beam crosses the room slightly nearer the cliff than the southeast wall; four cross poles support a ceiling of willows, cedar bark, and adobe mud. Several potsherds were used as chinking in the northeast wall. One peg protrudes from the upper southeast side, 3 inches from the east corner.

An 18 by 24 inch (0.46 by 0.61 m.) door opens through the middle northeast wall. Its lintel consists of three pieces of split cedar, supporting a large stone; its sill is a thin sandstone slab. Both outer jambs are slightly grooved for the usual door slab; loops for fasteners appear on each side. A mano was incorporated in the masonry under the outer north jamb; in the wall above, two empty holes for wall pegs may be seen.

Court 13 separates room 11 from room 14; on the southeast stands an inclosing wall, now 2 feet high. Room 12 is a later addition, built in the west corner of the court against room 11; sheer cliff forms the northwest side. The rock surface in the north corner had been pecked down to approximate the level of an adobe pavement which covers a deep debris fill against the southeast retaining wall. Open fires and the varied domestic activities pursued in the court have darkened its entire floor and left their mark on some of its surrounding masonry.

A shallow fireplace, rimmed with adobe (now much broken), lies at the base of the cliff 26 inches (0.66 m.) from room 12. Three slab fragments stand on edge back of this fireplace; within it we found a dressed sandstone tablet measuring 10½ by 9 by ¾ inches (0.26 by 0.22 by 0.019 m.). Near by a mortar, 11 inches (0.27 m.) in diameter by 14 inches (0.35 m.) deep, had been pecked into the rock floor 9 inches from the cliff and 2 feet 7 inches from the north corner. Its concave bottom and vertical sides are stained by fire and ash. Three grooves on stones of the northeast wall near the north corner show where implements were sharpened. Here also a protruding beam end and three shallow steps pecked in the cliff gave access to the roof of room 14; a fourth pecked step, or handhold, appears a bit higher on the cliff. The roof of room 11 was doubtless formerly reached by a ladder in the alcove south of room 12.

To aid passage to and from court 13 we substituted a notched cedar (pl. 27, A) for the old pecked steps in the north corner and placed a pole ladder in the south corner. Minor wall repairs were made, especially on the southeast.

Room 14, apparently a ceremonial chamber, stands between court 13 and room 15. Its floor is entirely of native rock, partially worked down in the west corner. On the northwest side a ledge slopes from the upper west corner to the floor at the north. The west half of this ledge was built up with masonry, filled with débris and capped with slabs 31 inches (0.78 m.) above the floor to form a shelf 12 inches (0.31 m.) wide at the northwest and 24 inches (0.61 m.) wide at the northeast.

The roof is supported by two central northeast-southwest beams; three others, side by side, lie next the cliff. On these beams fifteen cross poles support a layer of willows, mud covered. Ceiling and walls are heavily smoked. The lower two-thirds of the southeast and northeast walls are plastered while the southwest and northwest sides remain unsurfaced. Several small ovals and circles, made by pressing a pointed instrument into the new plaster, appear on the southeast wall; also, several casually incised lines. Two pegs protrude from the upper northeast side. Apparently after completion of the room, a vent about 4 inches in diameter was cut through the southeast wall, 14 inches (0.35 m.) below the cross poles and 4 feet 6 inches (1.37 m.) from the east corner.

A door opens through the middle southwest wall with its slab sill, slightly grooved where a stone ax was sharpened, at the court 13 level. Just within this door and continuing from its sill a sandstone slab which has settled 2 inches at the north tops a masonry platform 16 inches (0.41 m.) wide and 16 inches high. This platform lies between the wall and a masonry fire screen, 25 inches (0.64 m.) high by 27 inches (0.69 m.) wide by 10 inches (0.25 m.) thick, capped by a single stone. Pecked into the rock floor at the northeast base of this screen is an ovoid fireplace, 25 by 18 by 4½ inches deep (0.64 by 0.46 by 0.114 m.). In the ceiling above the platform an unrimmed smoke vent measures 6 by 10 inches (0.15 by 0.25 m.). Northwest of fireplace and platform the cave floor slopes upward toward the cliff; in this sloping surface four steps were pecked.

Four feet six inches from the north corner and 8 inches (0.20 m.) above the floor a second door opens into room 15. Loops for door fasteners protrude at points 8 inches and 12 inches (0.31 m.), respectively, from its grooved jambs.

Five pairs of pecked eyelets and others, unfinished, appear on the northwest cliff above the roof; here also is a narrow groove where some implement was pointed.

We repaired the walls, recapped them with a single course of stones, and patched several holes in the roof.

Room 15 may be identified as a storeroom from the absence of smoke stains on its inner walls and from the presence of grooves on its outer door jambs. Within the room, solid cliff sandstone slopes rather sharply downward toward the east corner, which was filled to provide a limited floor area. A rock ledge averaging 12 inches (0.31 m.) wide extends along the northwest wall base.

The roof is supported by a single beam seated 8 or 10 inches from the cliff and by three pairs of smaller timbers lying butt ends opposite. Upon these are five pairs of cross poles, covered with layers of willows and cedar bark. One peg protrudes from the southeast wall; five, from the northeast. A 17 by 24 inch (0.43 by 0.61 m.) door opens through the southwest wall 16 inches (0.41 m.) above the floor; two broad pieces of split cedar form its lintel. In the sloping sandstone beneath this door are five pecked steps.

On the northeast side a hole, approximately 20 inches in diameter and obviously of fortuitous origin, was repaired in 1917. In addition, the walls were recapped and holes in the roof mended.

Room 16 lies against the cliff, between room 15 and court 24. Its northeast and southwest walls are of masonry, but its southeast wall, now missing, was undoubtedly of wattle. Although the rock floor next the cliff had been worked down somewhat, it remains slightly higher than the front, filled portion. The east side of a low, narrow ledge at the base of the northwest, or cliff, wall was leveled with masonry to form a shelf. Smoke stains appear on the floor and at the base of all three walls.

The roof had burned, but one charred beam end remains in the northeast wall next the cliff, and three notches, pecked for beam rests, appear in the southwest wall. Above these, charred timbers protrude from room 15; the northeast wall masonry extends 18 inches (0.45 m.) above the roof level of room 16.

Room 17 is a possible storeroom situated between rooms 18 and 41; in front of and below rooms 15 and 16. Cliff forms its lower northwest side; its southeast wall is of wattle—posts supporting upright willows, bound at intervals by horizontal withes either singly or in pairs, and the whole plastered with adobe. (Pl. 9, A.) Smoke stains are not perceptible.

Excepting a small section in the west quarter the floor is artificial and rests upon 19 inches (0.48 m.) of débris covering an earlier surface. No plaster appears on the southeast wall below the upper floor, although its willows and posts extend to the lower. In the north corner a 9 by 12 inch (0.22 by 0.31 m.) shelf was made by leveling a small rock ledge with adobe. Above this shelf, next the northeast wall, is a recess measuring 8 by 12 by 5 inches (0.20 by 0.31 by 0.13 m.) deep. In the west corner pecked steps lead up the slop-

ing sandstone to a ceiling hatchway. Between floor and roof, one additional pecked step appears in the northwest wall; two in the southwest.

The roof is supported by four northeast-southwest beams. Upon these are 12 cross poles, only one of which extends the entire length of the room; then layers of split cedar, reeds (Johnson grass), and sand. In the west corner an 18 by 24 inch (0.46 by 0.61 m.) hatchway is reached by pecked steps. From the north middle beam a loop of knotted yucca leaves hangs 12 inches and is rather sharply curved at the bottom as though it once supported a pole approximately 2 inches in diameter. We recapped the walls and patched the broken edges of the roof.

Room 18 is a kiva, or ceremonial chamber, if one may judge from the character of its furniture. Its floor is mostly of native rock; its walls and ceiling are heavily smoked. The lower half of its northeast and southeast walls is plastered and in this appear miscellaneous scratchings—mostly vertical, parallel lines. Similar incisings may be noted on the northwest, or cliff, side. A sloping ledge along the face of this same wall had been leveled in the north corner to form an 18 by 30 inch (0.46 by 0.76 m.) shelf about 3 feet (0.91 m.) above the floor. During the initial examination of Betatakin in August, 1909, the present writer found two clay pipes and other articles on this shelf. They are now in the University museum at Salt Lake City.

The roof of room 18 includes 3 northeast-southwest beams, 10 pairs of crosspoles and layers, respectively, of willows and cedar bark. As usual, the willows are tied down to the cross poles by split yucca leaves. A door through the middle southwest wall has a slab sill and four oak lintel sticks about 1 inch in diameter; a 2¼-inch post stands against the inner south jamb. (Pl. 8, A.) Within the room, 20 inches (0.51 m.) from the southwest wall and separated from it by a platform lying 6 inches below the door sill, stands a masonry fire screen, 34 inches (0.86 m.) high by 27 inches (0.68 m.) wide by 10 inches (0.25 m.) thick. The platform extends a few inches beyond the south end of the screen; the latter is capped with a single sandstone block, 27 inches (0.68 m.) long by 13 inches (0.33 m.) wide by 3 inches (0.07 m.) thick. At the northeast base of this screen is a now broken, unrimmed fireplace approximately 2 feet (0.60 m.) in diameter; it was formerly lined with irregular stone blocks. In the roof above the platform, and obviously cut after completion of the ceiling, is a 7 by 10 inch (0.17 by 0.25 m.) smoke vent, rimmed with adobe-covered cedar bark. A second ventilator, 9 inches (0.22 m.) wide by 12 inches (0.31 m.) high, appears in the southeast wall 3 feet (0.91 m.) above the floor and 4 feet 5

inches (1.34 m.) from the east corner. Externally, this latter vent is almost round and about 6 inches (0.15 m.) in diameter.

During the snowstorms we experienced in 1917 my crew and I repeatedly sought shelter in this room and built fires in the south corner. Excepting minor patchwork along the roof edges and a new course of capping stones no repairs were necessary.

Court 19. During occupancy of the village this open space may have been leveled with débris. But to-day its sandstone surface, slightly higher in the middle, drops abruptly to the sloping cave floor between room 20 and the retaining wall below room 7. On the southeast side of the court a few courses of masonry cap the cliff terrace that serves as northwest wall for rooms 20-21. One sees no evidence of a passageway to court 13, above and at the northwest, but six pecked steps in the cliff at the north corner gave access to the roof of room 18.

At the cliff base, 3 feet 4 inches (1.01 m.) from the north corner, a pot-shaped hole 11 inches (0.27 m.) deep had been pecked in the solid rock. Three inches below the surface the diameter of this receptacle is 11 inches, but the body diameter, like that at the orifice, is 13 inches. Open fires had burned between this hole and the north corner of the court.

Room 20, a probable storeroom, stands below and south of court 19. (Pl. 10, B.) The face of a cliff terrace, thinly plastered, forms its northwest wall; the others are of masonry. Smoke stains are not present. The floor is mostly artificial. A cedar log is embedded in the masonry of the southwest wall, about 2 feet below the floor level.

Four northwest-southeast beams, two of which lie side by side in the middle of the room, carry 17 cross poles with overlying layers of willows and cedar bark. At the northwest all four beams rest upon a log which lies on a shoulder of the cliff, although notches for their individual support had been pecked in the cliff face above the log. Eight pegs protrude from the walls, close up under the beams; a hole for one additional peg is noted. The only entrance to the room is a hatchway, 20 by 24 inches (0.51 by 0.61 m.), in the south corner.

The terrace on which this storeroom was built had previously settled away from the cliff 14 inches; the resultant crack, extending lengthwise through the middle of the floor, had been filled with household débris. A 2-inch fracture in the northeast masonry evidences further settling since abandonment of the room. To check this we tied the southeast wall to the cliff with two steel rods, equipped with turnbuckles and expansion bolts. In addition, a hole in the lower southwest side was closed, the walls were recapped, and the roof patched.

Room 21, the longest in Betatakin, may also have served for storage, since its walls bear no trace of smoke. The sandstone cliff, capped with about 14 inches (0.35 m.) of masonry, forms its northwest wall; those adjoining on the northeast and southwest have been cracked by settling of the ledge on which the room stands. The floor is mostly native rock.

Four northwest-southeast beams supported the roof. Of this, only two cross poles now remain; upon them, in the west corner, are willows and cedar bark. Five wall pegs are noted, broken off flush with the masonry. Lacking evidence to the contrary, we assume the hatchway—sole entrance to the room—was located in the south corner, as in room 20.

The southeast wall we anchored to the cliff with a single steel rod. The north end of this, provided with an expansion bolt, was set in a drilled hole and packed with cement. In addition, we repaired the upper walls and replaced a missing beam. No effort was made to complete the roof.

Room 22, probably a kiva, adjoins room 21 and occupies the same terrace. Its northwest wall is formed by the face of the next higher ledge, topped by 2 feet of masonry. The lower three-fourths of all four walls are plastered and heavily smoked; the floor, mostly native rock, was worked down in the south corner to within 6 inches of the general level. Without lateral doors the chamber necessarily was entered through a hatchway.

Two northwest-southeast beams supported the roof; seven pecked rests for cross poles appear in the masonry of the southwest wall. At the floor level a 9 by 7 inch (0.22 by 0.17 m.) ventilator opens through the southeast wall 38 inches (0.97 m.) from the south corner. Extending into the room from the east jamb of this vent is a deflector slab, 17 inches (0.43 m.) wide by 16 inches (0.40 m.) high; at its northeast base lies a broken, stone-lined fireplace.

Two pecked steps at the west end of the northwest wall were doubtless cut before construction of the room; another "step," 6 inches (0.15 m.) wide by 4 inches (0.10 m.) high by 1 inch (0.025 m.) deep, appears in the middle of the same wall, 21 inches (0.53 m.) above the floor. Near by is a partially demolished shelf, 5 inches (0.12 m.) wide by 8 inches (0.20 m.) long, built of adobe on a narrow surface. One wall peg protrudes from the northeast side.

A rock ledge extending the entire length of the southwest wall was leveled in front with masonry to form a bench, 16 inches (0.40 m.) wide by 25 inches (0.64 m.) high. Four sandstone slabs surface this bench, the face of which had been battered by stone hammers and subsequently plastered. The crack caused by settling away of the terrace on which rooms 20–23 were built had been filled through-

out with rubbish. But in room 22 the southwest wall masonry continued down into this crack, thus leaving, under the paved bench, a recess 10 inches (0.25 m.) wide by 16 inches (0.40 m.) deep.

Incised designs appear on the plastered bench face and on all four walls. (Fig. 2.) An irregular rectangle about 5½ inches (0.13 m.) high by 7 inches (0.17 m.) wide, with crossed lines forming 100 small squares, is seen on the southeast wall; a similar figure shows faintly on the northeast side near the east corner, and just to the left of it is a familiar pottery design. The best preserved of all these incised

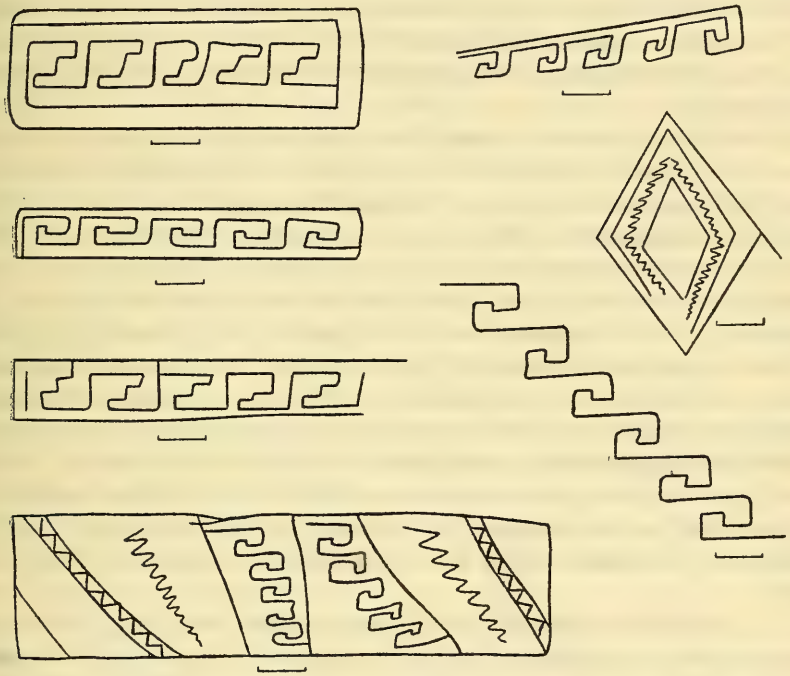


FIGURE 2.—DESIGNS CARVED ON THE WALLS OF ROOM 22. (THE BAR REPRESENTS 1 INCH)

figures appear on the middle northwest wall, in the plaster covering the cliff face; in addition, there are faint waved lines and miscellaneous scratchings. A series of six "turkey tracks," with other figures, will be noted in the plaster above the southwest bench.

To check settling of the southeast wall we anchored it to the cliff with two steel rods fitted with turnbuckles. Minor wall repairs were made.

Room 23 is a relatively small structure between rooms 22 and 42, south of and below passage 40. Its northwest wall is formed mostly by the perpendicular face of a ledge; the other three are masonry. Of the northeast wall only three stones remain and these lie in the

subfloor crack continuing through rooms 20–23; of the southeast wall, only a fragment in the south corner has survived. The floor is entirely artificial. Fires had burned against the southwest wall, near the south corner. Upon the floor at the base of the northwest wall lay 3 feet of old débris; above this, the looser earth and sand thrown out by earlier excavators.

Although the roof is entirely missing, two beam rests show in the stonework above the cliff and holes for five cross poles appear in the masonry of the southwest wall, 5 feet 6 inches (1.7 m.) above the floor.

The Douglass ground plan inadvertently shows the northeast wall of room 23 a continuation of that in room 39. Its correct position, evidenced by the masonry fragment in the subfloor crack, is indicated on Plate 3.

Court 24 lies between rooms 16 and 25. A cliff ledge on the northwest side forms a bench 18 inches (0.45 m.) wide at the west by 3 feet (0.91 m.) wide at the east; its middle surface rises nearly a foot above the remainder. At the east end, which stands about 3 feet high, a depression had been filled with spalls and débris; over this, a series of nine stone steps led from the court floor to the roof of room 26. At the opposite end of the bench four pecked steps gave access to the roof of room 16. Below this shelf is a second and narrower ledge from which the native rock floor slopes gently downward toward the south side of the court. Here a southeast wall supports a débris fill, approximating the level of the sandstone surface at the northwest. In the west corner two shallow mortar-like basins, 11 inches (0.27 m.) in diameter by 2 inches (0.05 m.) deep and 8 inches (0.20 m.) in diameter by 1 inch deep, had been pecked in the solid rock.

The southeast side and the adjacent wattled wall required minor repairs (pls. 11, A; 12, B) in 1917; three of the north steps were relaid (pl. 27, B) and a notched cedar was substituted for those pecked at the west.

Room 25, east of court 24, stands against the cliff immediately below room 26. Half of its wattled southwest wall was still standing; we reconstructed, but did not surface, the remaining portion. (Pl. 11, B.) The lower 3 feet (0.91 m.) of the three masonry walls had been surfaced; 10 superposed layers of plaster were counted in one place. Incised designs appear on all except the wattled wall. In the north corner, 2 feet 8 inches (0.81 m.) above the floor, is a triangular shelf measuring 7 inches (0.17 m.) on the northeast by 6 inches (0.15 m.) on the northwest. The charred ends of two beams, 8 inches in diameter, protrude on the northwest, 4 feet 5 inches (1.34 m.) above the floor; a lesser beam supported the top of

the wattled wall. Seatings for 10 crosspoles appear on the northeast side.

Three feet eight inches (1.11 m.) from the west corner a door, 18 inches (0.45 m.) wide and 10 inches (0.25 m.) above the floor, opens through the wattled wall into court 24. Against its inner north jamb stands a shattered masonry abutment, 9 inches (0.22 m.) thick. This joined the wall to a now missing fire screen which stood in front of the door to shield a fireplace, 24 inches (0.61 m.) in diameter by 5 inches (0.13 m.) deep, pecked into the rock floor. A subfloor cist 3 feet (0.91 m.) deep, about 2 feet 6 inches (0.76 m.) in diameter and lined with rough masonry, occupies the east corner of the dwelling.

In the northwest wall, 19 inches (0.48 m.) from the west corner and 13 inches (0.33 m.) above the floor, is a pecked recess measuring 4 inches (0.10 m.) square by 4 inches deep. A second recess of equal size and comparable depth lies in the northeast wall, 3 feet 6 inches (1.1 m.) from the north corner and 14 inches (0.35 m.) above the floor. A peg protrudes at an angle from the north half of the wattled southwest wall. In the upper southeast wall, near the east corner, is a 7 by 9 inch (0.17 by 0.22 m.) opening whose external dimensions are 5 by 6 inches (0.13 by 0.15 m.). A former ventilator, now blocked, about 11 inches (0.27 m.) wide by 14 inches (0.35 m.) high, is discernible at the floor level in the middle southeast wall.

Room 26, built upon an upper terrace northwest of and overlooking room 25, was used for storage purposes. Its rock floor slopes unevenly downward toward the southeast. Although the roof is missing, two pecked beam rests are noted in the northwest cliff; timbers protrude slightly from room 25. In the south corner three jutting stones in the northwest wall and two in that adjoining served as steps to a former hatchway.

In 1917 we substituted other timbers for the two missing beams and laid a hewn plank lengthwise of the room to facilitate access between courts 24 and 34.

On the cliff about 6 feet (1.82 m.) above the roof level of room 26 are four pairs of holes—shallow, pecked depressions connected by drilling. Two of these pairs are still occupied by small willows which protrude at right angles from the upper member. Like similar holes elsewhere on the walls of Betatakin cave, these were obviously prepared for suspension of maize, herbs, or equally light articles. They could hardly have been intended for loom cords since they are unequally spaced and the smaller pairs would not have resisted the tension required.

Room 27, a dwelling between rooms 25 and 100, stands below and in front of court 34. The cliff, surmounted by 18 inches (0.45 m.) of stonework, forms its northwest side; the southeast wall is of

wattle, mud covered. Only the lower half of the three masonry walls was plastered. The charred ends of three northwest-southeast beams are visible, and two of these lie side by side, near the west corner. At the southeast these three beams rested upon individual posts set just within the wattled wall. Seatings for five cross poles were pecked in the upper northeast masonry, but the former ceiling undoubtedly included 10 or 12 such timbers. The stonework upon the northwest, or cliff, wall was set back 5 inches (0.12 m.), thus forming a shelf the entire width of the room and about 4 inches (0.10 m.) below the beams. This shelf we repaired; at the same time the northwest and northeast walls were recapped.

In the middle southeast wall is a broken door. Within it, 22 inches (0.56 m.) from the wall, stands a slab fire screen measuring 25 inches (0.64 m.) wide by 14 inches (0.35 m.) high; its west end is joined to the wattled wall by slabs embedded on edge and extending 4 inches above the floor. At the northwest base of the screen is a fireplace, 7 inches (0.17 m.) deep, and averaging 16 by 21 inches (0.40 by 0.53 m.).

Court 28 lies between rooms 27 and 29, southeast of room 100. Like other courts, it served as an open living room in which diverse domestic activities were pursued. Its northeast wall, 5 feet 3 inches (1.6 m.) long, is of wattle (pl. 12, A); on the southeast a low retaining wall, extends westwardly to form a narrow passage fronting room 27. In the middle northwest side a door opens into room 100; both jambs are grooved and loops are present for wooden fasteners. Minor repairs were made on the wattled wall and on that adjoining at the southeast.

Room 29–30. A 2-story dwelling northeast of court 28 and room 100; southeast of and below room 31. Little remains of the upper chamber; the following notes pertain to the lower: For the most part, the floor is artificial, but along its northwest side the native rock had been worked down to approximate the general level. In the west corner a hole, 10 inches (0.25 m.) in diameter by 12 inches (0.30 m.) deep and now fire stained inside, had been pecked from the solid sandstone. Three shallow grooves where axes were sharpened appear in the northwest half of the room; here also are three pecked holes, averaging 2 inches in diameter by 2 inches deep, one of which contains a loom anchor stick. The wattled portion of the southwest wall was entirely plastered; of the others, only the lower half was so treated. No door being present, this lower room necessarily was entered through a hatchway.

The southeast wall was built upon a horizontal log. At the northwest, lying on a low ledge of rock and supporting the upper wall masonry, is a similar log; above it, 4 feet (1.2 m.) from the

sloping floor, is a second log (boxelder) and a foot higher, the charred ends of two pairs of northwest-southeast beams. A fifth beam, its ends only slightly embedded, rested close against the northeast wall. On this same side are recesses for, or the broken ends of, seven cross poles; three pole ends appear in the north 4 feet 3 inches (1.3 m.) of the southwest wall, the remaining 5 feet (1.5 m.) of which is of wattle. Extending along the base of this wattled section is a masonry bench 15 inches (0.38 m.) wide by 3 feet 4 inches (1.01 m.) long. An upright slab, 2 feet (0.60 m.) wide by 2 feet 8 inches (0.81 m.) high, adjoins the southeast corner of this bench as a screen for an ovoid fireplace. The latter measures 18 by 17 inches by 7 inches deep (0.45 by 0.43 by 0.17 m.); although pecked from solid rock, it is lined on the southeast and southwest by slabs. To further shelter this fireplace, a second upright slab, 12 inches wide by 2 feet high, extends eastwardly from the bench corner and the first screen. The bases of both these deflectors are supported by embedded slab fragments. In the west end of the south wall and at the floor level is an air vent, 8 inches (0.20 m.) wide by 12 inches (0.30 m.) high. The southeast masonry continues 2 feet beyond the abutting wattled wall. In the west corner narrow shelves on the northwest and southwest sides were capped with slabs. Only one wall peg is evident, on the southeast.

The second-story northeast wall apparently was added after completion of the lower room, for its basic stones are larger than the others. Although still in excellent condition, this upper wall shows no seatings for ceiling beams or cross poles; an unusual feature of it is the stepped construction at its south end, the "step" being 14 inches (0.35 m.) deep by about 30 inches (0.76 m.) long. (Pl. 11, A.) In this same second-story wall are two small recesses, approximately 5 inches (0.12 m.) wide by 4 inches (0.10 m.) high by 4 inches deep. One lies in the north corner; the other, in the middle wall and about 2 feet (0.60 m.) above the second-story floor level. The first of these recesses was plainly left during construction, but the second appears to have been made subsequently by removal of a few small stones.

Room 31, northwest of and above room 29, is another storeroom. Its floor is of native rock. A cliff terrace forms its northwest wall, but masonry was employed at each end to support the ceiling cross poles; between these seatings are three holes, pecked for other pole ends. A single northeast-southwest beam crossed the middle room. Through the southeast wall a 15 by 22 inch (0.38 by 0.56 m.) door opens upon the roof of room 29. The slab sill and both jambs are grooved; loops occur at either side.

After patching and recapping the walls, we presumed to reconstruct the roof. (Pl. 13, A.) Ceiling poles and willows were sal-

vaged from other sections of the village; new willows were brought in from the banks of the creek near camp. Upon the poles a layer of willows was spread and tied with strips of yucca leaves; upon the willows we placed a layer of cedar bark and covered it with dry sand. Although in roof construction they invariably used mud as a covering for willows or reeds, the builders of Betatakin seem often to have employed dry sand only in completing a roof in which cedar bark formed the next but final layer.

Room 32, northwest of and above room 31, also was utilized for storage. Unworked native rock, quite uneven and sloping sharply downward toward the south corner, sufficed as floor. In this slanting surface a single pecked step occurs. A shallow, pecked beam rest is noted on the cliff in the north corner; a few inches lower, but outside the northeast wall, is a similar recess, 5 inches (0.12 m.) in diameter by 2½ inches (0.06 m.) deep. It is conceivable that the builder's plans were altered during construction.

Through the middle east wall a 16 by 24 inch (0.40 by 0.61 m.) door opens upon an irregular bench. Although its lintel had disappeared both jambs are grooved and the remains of willow loops show at either side.

In repairing this room we placed two adjacent beams parallel with and next to the northwest, or cliff, wall; a single beam was embedded in the restored masonry near the southeast wall and three steps at the east end were enlarged.

Room 33, on a ledge west of room 32, is yet another storeroom. Its floor is of native rock, higher in the middle than at either end. One peg protrudes from the upper southeast wall; no doubt others were formerly present.

A door, 15 by 20 inches (0.38 by 0.50 m.), opens through the middle southwest wall. Its south jamb is a stone slab on end; the other, an upright stick embedded in adobe. Outside, both are rounded off with mud and grooved for a door slab; holes at either side were once occupied by willow loops. The lintel is a stone slab supported by six strips of wood; the sill consists of two slabs set at different levels. The uppermost of these, 11 inches (0.27 m.) wide by 13 inches (0.33 m.) long, lies 6½ inches (0.16 m.) above the lower; the latter, 8 inches (0.20 m.) wide by 15 inches (0.38 m.) long, lies 7 inches above the general floor level. Outside this door the cliff ledge forms a flat space approximately 2 by 4 feet (0.60 by 1.2 m.).

We placed two salvaged beams lengthwise of the room, seating their ends in the restored upper northeast and southwest walls.

Court 34 lies between rooms 26 and 31, in front of and below room 33. The face of the narrow ledge on which rooms 32–33 stand forms its northwest side; at the west corner seven pecked steps lead up and over this ledge to the roof of room 26. In the north corner three

similar steps and a fourth in the outer wall of room 31 gave access to the roof of the latter. The court floor is mostly artificial and continues at the same level with the roof of room 100.

We substituted a notched cedar for the west steps and placed a similar, though larger, ladder in the north corner.

Room 35, a dwelling, is situated between room 37 and court 45. We observed no evidence of the second story shown in Douglass's ground plan as reproduced by Fewkes (1911).

The northwest side is sheer cliff, surmounted by rooms 29 and 30; the southeast and southwest walls are masonry; the northeast, of wattle. While the latter was surfaced all over, only the lower half of the other three was plastered. The north part of the floor is native rock, worked down nearly 2 feet (0.60 m.) in the west corner and along the southwest side. A slab-lined but screenless fireplace, 18 by 20 inches (0.45 by 0.50 m.), occupies the middle floor. Three feet two inches above the floor a 5 by 9 inch (0.12 by 0.22 m.) opening extends diagonally through the middle southeast wall. In the west corner, 11 inches (0.27 m.) above the floor, is an 8 by 4 inch (0.20 by 0.10 m.) shelf.

A small beam lies against the northwest cliff; two larger northeast-southwest beams cross the middle room. At the northeast these three timbers rested upon individual posts set just within the wattled wall. Although five cross poles (1 single, 2 pairs) appear in the southeast wall, at least four others were formerly present.

In 1917 we repaired but did not replaster the wattled wall; we reconstructed the rounded adobe sill of its door and rebuilt the central fireplace.

Court 37. The northwest wall is sheer cliff, 8 feet (2.4 m.) high, surmounted by the retaining wall fronting court 28. No beam rests appear on this side. Two beam ends from room 35 protrude through the northeast wall, which apparently never extended more than 5½ feet (1.7 m.) above the court floor. Of the southeast side only traces now remain in the east corner. At the northwest is the cleaved end of a rock ledge on whose sloping surface stands the fragmentary northeast wall of room 39, ending abruptly with the southeast face of the ledge. Court 37 lies several feet below passage 40, but connects with it by a single pecked step. Other similar steps may long since have disappeared with disintegration of the soft, friable sandstone.

Bone awls were pointed on the northwest cliff face; stone axes were sharpened on the sandstone floor. In the west corner four steps were pecked in the gently sloping surface where steps seem quite unnecessary.

We observed no suggestion of the second story indicated on Douglass's ground plan.

Room 39 is a dwelling, between rooms 41 and 37. Its northwest wall is formed by the face of a cliff terrace, surmounted by room 25; a fragment of northeast masonry remains at the north. The southeast wall, of wattle construction, was plastered all over; successive plaster layers show on the lower half of the northwest and southwest walls. While the north half of the floor is of native rock, the remainder consists of a debris fill surfaced with adobe. A protruding rock mass on the southwest side had been worked down 5 inches to the general floor level. Through the middle southeast wall a door gave access to passage 40, which in turn connects with court 37.

A narrow ledge lies at the base of the northwest, or cliff, side; on this ledge, in the north corner and abutting the northeast wall, stands a masonry column, 12 inches square, that probably once reached to the ceiling. The lower half of this column is plastered; its southeast face is smoked. On the same rock ledge and abutting the southwest side of the column is a masonry shelf, 8 inches (0.20 m.) wide by 2 feet 3 inches (0.68 m.) long. An adobe-rimmed fireplace, the north side of which lies 3 feet 5 inches (1.04 m.) from the middle southeast wall, had been partially destroyed with caving of the east quarter of the floor. Both firescreen and door-sill were lost at the same time.

Pecked into the rock floor at an average distance of 17 inches (0.43 m.) from the cliff are four loom anchor holes averaging 2½ inches (0.06 m.) in diameter. The westernmost of these lies 2 feet 8 inches (0.81 m.) from the southwest wall; the second, 16 inches (0.40) from the first; the third, 16 inches from the second and 16 inches from the northwest wall; the fourth, unfinished, lies 8½ inches (0.21 m.) from the third and 19 inches (0.48 m.) from the cliff. Another incomplete hole is noted on the north side, between the third and fourth. Hole No. 1 contained a ⅜-inch stick embedded 1 inch below the room floor; hole No. 2 held two quarter-inch sticks, placed one upon the other, with the uppermost 1¼ inches (0.031 m.) below the floor; hole No. 3 contained a single stick. Each anchor rested in an undercut at one side of a vertical groove (fig. 3); each had been introduced through the groove into the undercut, after which both groove and socket were packed with adobe mud. At some later time all five holes were filled with mud; their presence was disclosed by the difference in color between this adobe filling and the sandstone. From the uniformly discolored floor here we infer the loom anchors were in disuse long before abandonment of the room.

Room 40, a passageway about 21 feet (6.4 m.) long, furnished access from court 37 to rooms 39 and 41 and the roof of room 22. At its west end the alley is 18 inches (0.45 m.) wide; between rooms

39 and 41 it attains its maximum width of 35 inches (0.88 m.). The southeast wall probably did not extend more than 3 feet (0.91 m.) above the floor level and may have been stepped down at the east end. An earlier débris-covered floor lies 6 inches (0.15 m.) below that last utilized.

The masonry separating rooms 39 and 41 ends flush with their wattled southeast walls, instead of continuing, as shown on Douglass's plan.

Room 41, between rooms 17 and 39, opens into passage 40. As so frequently happens in Betatakin, its northwest wall is formed by the face of a rock ledge, in this instance surmounted by the southeast wall of court 24. A fracture in the cliff, 4 inches (0.10 m.) above the room floor, left a flat surface 12 inches wide by 3 feet (0.91 m.) long.

The northeast and southwest walls of the room are of masonry; the southeast, of wattle. The roof had been supported by at least two large northwest-southeast beams whose south ends rested on posts incorporated within the wattle construction. Charred ends of nine cross poles protrude from the southwest wall. The floor, almost wholly of solid rock, had been pecked away more than 2 feet in the west corner. Such an excavation, made only with hammerstones, furnishes ample proof of the patience and industry of prehistoric Pueblo workmen.

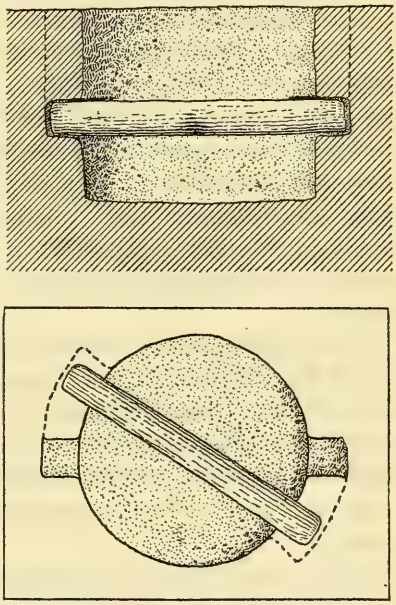


FIGURE 3.—CROSS SECTION AND PLAN OF LOOM ANCHOR

A doorway, with stone sill slab lying 3 inches above the floor and wholly outside the door, pierced the middle southeast wall. Directly in front of and 15 inches (0.38 m.) within the door stands the remnant of a masonry fire screen, 30 inches (0.76 m.) wide by 7 inches (0.17 m.) thick; an upright stone slab connects its west end and the southeast wall. It is not improbable that this slab, like others present in houses with wattled south walls, was intended both as a secondary screen for the fireplace and as a check for sand carried by the winds which usually sweep through the cave from east to west. In 1917 we had ample opportunity to observe the force of these winds and the amount of sand they transported. The fire-pit, pecked from

the solid rock floor, measures 2 feet 4 inches (0.71 m.) long by 16 inches (0.40 m.) by 5 inches (0.12 m.) deep.

When we repaired the upper northwest wall no effort was made to indicate positions for the principal ceiling timbers.

Room 42. The long room numbered 42 on Douglass's plan is not now traceable, although the ledge which marks its site, especially at the west end next room 23, is wide enough and not too sloping to have supported a room. Débris covering the floor of room 23 extended downward and across the sloping surface of this ledge. No portion of the southeast wall shown by Douglass is evident.

Room 43, a dwelling, stands between rooms 48 and 49, above court 45. Five medium-sized beams were covered directly with a thick layer of Johnson grass to form its ceiling; there were no cross poles. In the west corner native rock was worked out to a depth of 16 inches (0.40 m.); the remaining floor is a rubbish fill, surfaced with adobe. Part of the southeast wall had fallen, releasing some of the débris. Two feet four inches of the northeast wall consists of room 51 stonework; the remainder, of wattle (now mostly destroyed), apparently replaced a masonry wall 7 inches (0.17 m.) thicker. The southwest side, also of wattle, was built in after completion of the roof which covers both rooms 43 and 48. All four walls are heavily smoke stained.

A door through the middle of the northeast wattled wall has four thin strips of split cedar to support its stone lintel; as usual, a slab forms its sill. Another door, 16 by 20 inches (0.40 by 0.50 m.), opens through the middle southwest side; its sill is a slab on edge, 11 inches high. A fireplace, now broken but probably slab-lined, lies 15 inches (0.38 m.) inside the northeast door. We observed no trace of a screen.

In 1917 we propped a broken beam with a post, replaced two other beams, patched the roof edges with willows and cedar bark, repaired the broken southeast wall, and filled the floor break above noted.

Room 44, above and northwest of room 51, is a storeroom. On account of the sloping cliff at the northwest the floor area is reduced to half that of the ceiling. Two large slabs of rock had slipped down the cliff (pl. 13 B), breaking the northeast wall and pushing it outward 7 inches (0.17 m.) from its original position. The southwest side was built over a ledge which had been worked down within the room. Smoke stains appear on all four walls; more prominently in the south corner. Two narrow, groovelike notches were pecked in the cliff near the west corner, perhaps as beam rests. Only two cross-pole fragments, one at each end of the room, remained in place.

A former northeast door had been blocked; its jutting lintel slab and the recessed masonry above, form a shelf 6 inches (0.15 m.)

wide by 2 feet 8 inches (0.81 m.) long. A later door, 15 by 25 inches (0.38 by 0.64 m.), opened through the southeast wall onto the roof of room 51; two stones composed its sill. Although the outer jambs of this second door are slightly grooved, fasteners were not provided.

Restoring the southeast door in 1917, we seated a single lintel slab, without supporting sticks. To suggest the original beam level, a pole was placed parallel with the cliff.

Court 45 lies in the left front of the village with room 35 adjoining on the southwest; rooms 46 and 50, on the northeast. The northwest side is sandstone cliff, sloping up from the floor to rooms 29, 43, and 48. The southwest wall, of wattle, is divided by a door whose slab sill lies 4 inches above the court floor. At each side of this door stands a post, joined to the wall by 6 inches of masonry. In the upper middle of the southeast inclosing wall was an opening (reproduced in 1917) slightly larger than the usual "windows" or ventilators.

Most of the court floor is artificial; fires had burned in various places. Several pecked steps lead up the sloping northwest side to a small flattish area in the corner formed by the outer walls of rooms 29 and 48. Two loom anchor holes, pecked in the north corner of the main court floor, each measure 3 inches (0.076 m.) in diameter by 2½ inches (0.06 m.) deep; a third hole, unfinished, lies slightly to the west. A narrow bench, 8 inches (0.20 m.) wide by 14 inches (0.35 m.) high, extends nearly the entire length of the northeast wall and serves as a sill for the door to room 46. This door measures 18 inches (0.45 m.) wide by 25 inches (0.64 m.) high; staples appear at each side.

Where it abuts the nearly vertical cliff, the northeast wall was built into a dug groove about 3 inches deep. (Pl. 14, B.) We repaired the broken masonry here, repaired the wattled southwest wall, and did miscellaneous patching elsewhere.

Room 46 stands east of court 45 and southeast of room 50. Its northwest and southeast walls follow the irregular cliff ledges on which they were built. For example, the southeast wall extends 4 feet 9 inches (1.4 m.) from the south corner to a northwest-southeast jog, 2 feet 3 inches (0.68 m.) long; thence, 3 feet 7 inches (1.1 m.) to the east corner. The northwest wall, standing on parts of two narrow sloping ledges, has a similar offset 3 feet 10 inches (1.16 m.) from the west corner and 5 feet (1.5 m.) from the north corner. While the floor consists mostly of native rock, depressions along the southeast side were filled and surfaced with adobe.

A door opens through the southwest wall into court 45; 24 inches (0.61 m.) below its sill a step, 6 inches (0.15 m.) wide by 17 inches (0.43 m.) long, was pecked into a protruding mass of native rock.

The crude masonry of room 46 required much repair in 1917. The west end of its northwest wall was rebuilt to furnish support for the south corner of room 50, but no attempt was made to show beam seatings.

Room 47, adjoining room 46 on the east, occupies a sloping rock surface in the lower middle front of the cave. Only the southwest and part of the southeast walls remain. The pecked groove on which the northwest masonry rested continues to the probable north corner where we restored a small section in 1917. The east half of the southeast wall, built on a lower ledge, necessarily includes masonry much higher than that in its west half. Within and against this wall a very considerable fill of débris provided a floor the former level of which is not now evident.

Room 48 is a small chamber that originally formed part of room 43, which it adjoins on the southwest. Its two roof beams support numerous small cedar sticks and a thick layer of Johnson grass. Owing to the sloping cliff on the northwest side, the floor area is reduced to less than half that of its ceiling. For example, the floor measures 2 feet 8 inches (0.81 m.) by 16 inches (0.40 m.), while the ceiling measures 2 feet 8 inches by 4 feet (0.81 by 1.2 m.). The wattled northeast wall is not plastered as is its opposite face in room 43. A triangular space between the cliff and the northeast door is occupied by a single large stone, forming a low shelf 5 by 14 inches (0.13 by 0.35 m.). The inner walls are heavily smoked.

The lower southeast masonry, having fallen, was replaced in 1917 (pl. 14, A) and the floor brought up to its former level.

Room 49 stands on a ledge northeast of room 43, between rooms 50 and 51. The northeast wall has wholly disappeared; the southeast, a fragment only of which remains, formerly concealed a large, rounded rock mass that lay just below the floor level of the east quarter. Absence of seatings for ceiling timbers suggests that room 49 might have served as a court, its floor at the roof level of room 50 or possibly separated from it by low stonework.

Part of a slab-lined fireplace will be noted against the southeast wall near the south corner. Through the middle southwest wall a door connects with room 43; a second door, whose grooved west jamb only remained, opened into room 51 through the west half of the northwest wall. We partially restored this latter wall and its broken door in 1917.

Room 50 lies north of court 45, between rooms 46 and 49. Its northeast wall is wholly missing, while that on the northwest is represented merely by sections of masonry at the west corner and under the bowlderlike rock noted below the east corner of room 49. Of the southeast side, a fragment remains in the south corner; the adjacent southwest wall is complete and shows seven holes left by

cross poles. The lower half of this latter wall is plastered and smoke stained. Native rock at the base of the northwest side had been worked down to the general floor level; elsewhere, the floor was of abode mud over a débris fill. This rubbish covered three earlier steps, pecked in the sloping sandstone.

In 1917 we rebuilt an alcove in the west corner; reconstructed the northwest wall and thus again concealed all except the protruding east end of the rock mass under room 49. A beam was also replaced on top the northwest wall.

Room 51 may be found in front of and below rooms 44 and 56, northwest of room 49. North of the angle in its southwest wall, rude masonry holds back the débris forming a level for the unnumbered court marked "Bench" on Douglass's ground plan. Four shallow steps, pecked into the sloping rock floor of this west corner, suggest the rude masonry above them was added when room 51 was constructed in this space, originally used as a passageway.

The lower west half of the northwest side is sandstone cliff, with room 44 above and at the roof level; the remainder is the masonry foundation of the wattled southeast wall of room 56. Stones loosely piled in débris marked the northeast wall. In the middle southeast wall a door connected with room 49; east of this opening the masonry had fallen.

We supplied a new sill for the southeast door and partly reconstructed both the southeast and northeast walls. In the latter, we left an irregular opening to provide ready access to the ladder placed in the west corner. The north leg of this ladder stands in a shallow hole we pecked in the sloping cave floor.

Room 52. The only traces of this structure were a few superposed stones of its southwest wall and several others under the north edge of the bowlderlike mass upon which the southeast wall had rested. Room 57, at the northwest, may have opened onto the roof of this building, although we have no reason to say it did. Room 56 protrudes slightly into the west corner from which a low ledge, worked down several inches, extends the entire length of the room. Two cup-shaped depressions had been pecked into the cliff floor as rests for the northeast masonry.

We reconstructed portions of the southeast and northeast walls in 1917 and left an opening in the northeast side to facilitate access to the rooms beyond. (Pl. 15, B.)

The series of pecked steps under the southwest wall of room 52 is a continuation of the trail which passes up the slope westwardly from room 55. These steps and the fact that all partitions had abutted the major northeast-southwest walls seem to indicate that rooms 51, 52, 53, etc., were later additions to the village, built upon

the narrow ledge previously used as a passage between the east and west house groups. It is certain that the ledge crossing the cave at this level was used as a trail for its course is marked by pecked steps and otherwise. (Pls. 6, B; 15, B.) Water seeps out just above the old path, providing lodgment for wind-driven sand and moisture for growing plants. From this area we removed a thick mat of columbine and other vegetation. Also we cleared the old trail and deepened some of its more weathered steps.

Room 53. In front of and below room 60–61, the pecked out cliff between room 52 and the projecting southeast wall of room 64–65 marks the former floor level of room 53 and its northeast-southwest length as 8 feet 7 inches (2.61 m.). A shallow groove, pecked in the sloping sandstone, served as a rest for the southeast wall, in continuation of that in room 52.

During our repairs six steps were cut in the cave floor of room 53 to facilitate access to the western portion of the ruin.

Room 54. Not indicated on Douglass's plan.

Room 55, obviously a ceremonial chamber, stands in the lower middle front of the cave. Like other Betatakin kivas, its special function is evidenced by certain furnishings never present in secular structures.

Although the south wall is now missing its former position is marked by a pecked rest on the cliff face below the floor level. The east and west walls stand more than 7 feet (2.13 m.) in height without trace of beam seatings; unlike any other in the ruin, they measure over 2 feet thick and include a core of sandstone spalls and adobe, faced on each side with masonry.

On the north the sharply inclined terrace face was squared up in front with masonry to form a shelf 18 inches (0.45 m.) wide at the east and 10 inches (0.25 m.) wide at the west, extending the entire length of the room, 3 feet 11 inches (1.19 m.) above the floor. In the middle face of this shelf, 22 inches (0.56 m.) above the floor, is a pecked hole, 7½ inches (0.19 m.) in diameter by 3 inches (0.07 m.) deep; above the shelf, where the room length is a few inches less than that below, masonry continued to the roof level. The walls were plastered and smoke stained.

Filling was necessary adjacent to the south wall, but elsewhere the floor is the flat surface of the lowermost terrace. In this are four loom anchor holes, averaging 3 inches (0.07 m.) in diameter by 2¼ inches (0.056 m.) deep. They were pecked in the sandstone about 12 inches (0.30 m.) from each other and about 17 inches (0.43 m.) from the base of the north shelf; each hole lacks its former anchor stick.

Built in the lower northwest corner is a triangular bench, 2 feet 3 inches (0.68 m.) high by 2 feet 4 inches (0.71 m.) on the north and

3 feet 7 inches (1.09 m.) on the west. In the face of this bench, at the floor level, is a recess measuring 6 inches (0.15 m.) wide by 18 inches (0.45 m.) high by 11 inches (0.27 m.) deep; its unplastered interior is but lightly smoked.

At the beginning of our 1917 excavations débris sloped downward from near the present top of the north wall, covering the floor and extending beyond its south margin. In this rubbish were quantities of cedar bark, sticks, and adobe flooring from dwellings higher in the cave. We repaired the northwest corner bench and the broken edge of the north shelf; recapped the walls and replaced some of the missing plaster. (Pl. 23, B.)

Room 56 lies north of room 51, between rooms 44 and 57. Its northeast and southwest sides are of masonry, but its southeast wall, above a masonry base which supports a débris fill and the floor level, appears to have been of wattle construction. There is no trace of masonry abutting the outer east corner of room 44. Of the northeast wall only a small section remained; in this, next the cliff, was the charred end of a ceiling cross pole and, in the lower front portion, the north jamb of a door. An offset in this same wall forms a triangular shelf, 12 inches (0.30 m.) wide by 18 inches (0.45 m.) long, against the cliff and just below the ceiling level. The slab sill of the blocked door to room 44 protrudes 4 inches (0.10 m.), forming a shelf 2 feet (0.60 m.) above the floor.

From the built-in floor the cave surface slopes sharply upward to the rear cliff, which may have served as the northwest wall of a second-story room.

In the débris-filled front part of the room were three mealing bins. For two of these the inclosing slabs were still in position when our excavations began; those of the third bin had fallen. The two bins measured 28 inches (0.71 m.) long by 17 inches (0.43 m.) and 14 inches (0.35 m.) wide, respectively. Although the original metates were missing, their angle of inclination was evidenced by the adobe packing inside the bins.

In repairing this chamber we set three posts just inside the masonry base of the southeast wall to suggest the wattling which probably once stood there. Also we partly rebuilt the adjoïning northeast wall while retaining its original irregularities. But it should be understood that the present dimensions of the restored door are approximations only. We reset the slab sides of the three mealing bins and substituted for those formerly employed, metates salvaged from other sections of the ruin. (Pl. 18, B.)

Room 57 lies between rooms 56 and 60; in front of and below room 58; above and behind room 52. From the rather precipitous cave floor a section 20 inches (0.51 m.) high by 12 inches (0.30 m.) deep and extending the entire width of the room had been battered away

with hammerstones. This excavation doubtless marks the former floor level, the front portion having been filled in with rubbish and surfaced with adobe as in so many other rooms, similarly situated. Two charred beam ends protrude from the upper southwest wall, next the cliff. A long narrow groove, pecked in the sandstone, formerly supported the now missing southeast wall. This latter, as in the case of room 56, we assume to have been of wattle above a masonry base that rose only to the floor level. It should be admitted, however, that we have no real justification for the assumption.

We deepened the southeast wall groove and, upon it, reconstruced the masonry foundation to approximately its original height; the adjacent sides were also represented by limited stonework built upon deep steps we cut to replace the shallow, pecked seatings provided by the aboriginal masons. (Pl. 17, B.)

Room 58 is merely a platform fronting room 59. When examined in 1917 its retaining (southeast) wall extended only one course above the landing; there was no certain evidence of a former southwest wall, although several large stones had been piled in there, below the floor level.

Directly in front of the door to room 59 is a groove where a stone ax was sharpened. On the slanting cliff west of the platform is a single pecked step which, with similar steps on the large rocks that had slumped into room 44, suggests that room 59 was entered from above the roof levels of rooms 44 and 56.

We added a second course of stones on the southeast side and, perhaps erroneously, replaced the loose subfloor blocks at the southwest with masonry extending two layers above the platform level.

Room 59, a probable storeroom, situated high in the middle portion of the cave, above and northwest of room 60–61. The foundation of its southeast wall was supported by a log resting upon the precipitous cave floor with its ends embedded in the northeast and southwest walls of room 60–61. A post about 6 feet (1.82 m.) high and reaching from floor to arching cliff above was incorporated in the masonry at the north corner. Rough stonework fills the space between this post and the adjacent lower cliff, thus creating an angle in the northeast side as shown in Plate 3. Smoke stains are discernible on the lower walls. Although the floor is mostly of solid sandstone, a shallow fill was made in front. Pecked in the rock floor at the west end is a seemingly unnecessary step.

The roof was supported by two parallel beams next the cliff and a third, now missing, toward the front. Through the middle southwest wall, with two large cedar sticks as lintel, is a 17 by 30-inch (0.43 by 0.76 m.) door. Its outer jambs are not grooved; hence the space within may not have been utilized solely for storage purposes.

During progress of our work the southeast wall collapsed, for reasons explained below. It was subsequently rebuilt; the space behind its supporting log was filled with spalls and covered by slabs extending out over the timber thus to provide a sturdier foundation for our new stonework. A salvaged pole replaced the missing ceiling beam.

Room 60–61 lies northeast of room 57, in front of and below room 59. The front wall continues from that in room 57 and, like it, rested on a pecked groove several feet below the actual floor level. We observed nothing to indicate that this wall included other than masonry. The two sides were erected above series of shallow, pecked steps. Some notion of the degree of inclination here may be gained from the fact that the floor length of the lower room is less than half its ceiling length. It is possible, therefore, that the lower chamber was utilized primarily for storage while the upper provided living quarters.

Part of the northeast wall and a small section of that adjoining on the southeast were in position when our work began. But these fragments, cracked by previous settling (pl. 16, A), collapsed utterly on April 18 after their adobe mortar had softened under the clinging snow of successive storms. Twelve days later, while we were reconstructing these fallen walls upon more deeply cut steps (pls. 17 and 18), the upper northwest wall gave way owing to vibrations set up by the reverberating echoes of an unusually severe thunderstorm. This wall, which serves as a foundation for room 59, was also reconstructed and upon its original horizontal supporting log. Our experiences here afford evidence of two distinct factors contributing to the destruction of cave dwellings.

A third factor might be noted in passing, namely, the abrasive property of wind-blown sand. As blown sand contributed to the creation of Betatakin cave, so has it played a part in destruction of those prehistoric dwellings subsequently built within that huge cavern. When the spring sandstorms were at their worst our work was repeatedly interrupted. The wind that leveled camp on April 9 and hung our spare clothes on far, high branches also drove us to seek shelter in the old rooms. Scouring sand cut pellets from the cave roof and showered them down with surprising velocity. Came, also, occasional larger stones. Storms of comparable temper persisted well into May. Blown sand has left its mark on both cave and house walls; masonry has been undercut and thrown down. Over a period of years the amount of destruction so caused might prove not inconsiderable.

Room 62. As shown on Douglass's ground plan, this room does not exist.

Room 63 is a small storeroom adjoining room 59, above and northwest of room 64–65. The cliff at the rear rises vertically to the gallery wall. As with rooms 58 and 59 a masonry foundation on the southeast side rose to the floor level; of the northeast wall, only a few stones remained in position. In 1917 we added several courses to these two fragmentary walls.

Northeast of room 63 the ledge upon which it stands bears several grooves where stone axes were whetted; farther along, this ledge narrows and disappears. But the line of cleavage continues as a seepage zone from which, in 1917, rippled a fluffy green band of columbine. A second similar band grew down slope, on a parallel seepage extending eastwardly from room 53. Over and below this lower seep, wind-blown earth and sand had gathered to a depth of 3 feet (0.91 m.); in this grew several oaks and box elders, from 3 to 5 inches in diameter. The decaying trunks of others were disclosed during removal of the accumulation.

Room 64–65. Of this structure only one wall was standing in 1917. (Pl. 16 A.) The lower story, quite V-shaped, might have been utilized for storage; with equal plausibility, it could have been packed with rubbish. Pecked grooves and steps as former wall rests and a difference in floor coloration marked the house site. Where once covered by masonry, the slanting sandstone remained unsoiled; elsewhere it was darkened by ash and débris of occupation. As in other structures similarly situated, the floor level of the lower room is now represented by a battered and partially excavated cliff section from which an adobe-surfaced, rubbish fill formerly extended to the front wall. This latter had been erected above a pecked groove 2 feet 8 inches (0.81 m.) lower on the slope than the southeast wall of room 60–61, which adjoins on the west.

Before construction of the dwelling several dissociated steps had been pecked on this lower slope. These were never actually used as wall seatings, although they may have been intended as such. There is also the possibility that they served as foot rests during building operations or as earlier trails across the precipitous cave floor.

Upon specially prepared cuts we reconstructed so much of the front and side walls as would indicate the original position and size of this room. (Pls. 17 and 18.)

Room 66 is identified as a second-story dwelling in the lower, middle portion of the cave. We find here a certain discrepancy in the Douglass ground plan. Therein, room 66 is shown as a 1–story house separated from a 2-story structure (R. 68–69) by narrow room 67. As a matter of fact, room 68 is barely traceable; room 66 is the only one of the three chambers having two doors in its west wall. One of these occurs in the first story; the other, in the second. If

one takes these two openings as the distinguishing feature of room 66, its correct position relative to its neighbors will be that shown by our Plate 3.

The upper story of this structure had burned during occupancy for the charred beams and willows of its original roof still show in the wall masonry 3 feet 10 inches (1.2 m.) above its floor. Subsequently, a new ceiling was constructed approximately 6 inches (0.15 m.) above the remains of the earlier. Only one door occurs and that in the west wall, near the southwest corner; it measures 18 inches (0.45 m.) wide by 31 inches (0.78 m.) high. Two feet inside this door and 2 feet 6 inches (0.76 m.) from the south wall is a slab-lined fireplace, 13 by 24 inches (0.33 by 0.61 m.) by 9 inches (0.22 m.) deep; it was protected by a wattled firescreen whose charred willows are still visible. Between this screen and the door, 4 inches (0.10 m.) below the sill, is a platform measuring 20 inches (0.51 m.) wide by 8 inches (0.20 m.) high; on the south side of this, joining screen and west wall, one notes the fragment of an upright slab which once served as a secondary deflector. In the middle south wall, 3 feet 5 inches (1.04 m.) above the floor, is a 6-inch square smoke vent.

During our 1917 repairs we replaced one of the missing upper beams and added split sticks and a stone lintel to the broken west door. The adobe floor was patched where needed; the walls, recapped.

Beneath room 66 is an unexcavated, débris-filled chamber whose floor area, on account of the sloping cliff, is considerably less than that of the upper story. In the north half of the lower west wall is a partially blocked door. (Pl. 9 B.) While some of the closing stones may have been removed within recent years, the writer seems to recall that this particular opening was in much the same condition when Betatakin was discovered by Professor Cummings in 1909. We presumed to close it completely in 1917.

Room 67 is a narrow building, east of room 66. Only a decayed fragment of its south wall remained and this we replaced in 1917. The adjoining sides had entirely disappeared; no grooves were present to mark their former positions. The north wall, about 5 feet (1.5 m.) long, was doubtless a continuation of that in room 66.

Room 68. Of this structure no trace survived except the battered cliff edge, east of room 67. Here the south wall had stood; the east and west sides doubtless continued from those in room 122, which lies next on the north.

Room 70 formerly rested precariously on the cliff edge, east of rooms 68 and 122. Pecked wall seatings give the approximate dimensions recorded in the table on page 73. The stonework had en-

tirely disappeared with the exception of a small north section supporting the artificial platform adjoining room 122, at the foot of the steps leading to room 73 and beyond. Upon the seatings they formerly covered we partially reconstructed this retaining wall and those adjacent.

Room 71. Although no masonry remained at the time of our work, the former presence of this room, on the lower cliff terrace east of room 70, is well evidenced by the series of steps pecked for support of its north wall. These steps may be noted on the upper edge of a slight break in the sloping cave floor; they extend thence, eastwardly toward the cliff edge. Below the break mentioned the native rock had been battered away to mark the floor level.

Room 72. Not shown on Douglass's plan.

Room 73 is a small storeroom built midway of the old step series leading from room 122 to the upper east end of the cave. (Most of these steps were enlarged and deepened in 1917.) The east, west, and south walls are of masonry; the north side is an acclivity, about 2 feet high, on which a number of horizontally pecked steps may represent footings for former masonry. But these steps continue to the west of room 73, along the crest of the same slanting ledge.

Abutting the outer southwest corner of the storeroom a short retaining wall supports a platform, partially made with débris, at a turn in the old trail. Fires had burned on this platform. A crack in the north, or cliff, side had been enlarged by pecking and continued, in snakelike fashion, downward toward the floor.

Construction of room 73 caused annoyance to some of the villagers, since it formed an obstacle on their much-traveled trail between the east and west house groups. Those most deeply irritated thereafter used another step series at the very top of the sloping sandstone; the others soon made a new path close on the north side of the granary.

In clearing room 73 we found numerous corn cobs and a small circular basket. (Pl. 42, 1.) Also, a stone ax was discovered in a recess created by removal of a stone from the lower south wall.

Room 74. The former presence of this room is evidenced by a fragment of masonry at the northeast corner; by the battered cliff at the floor level and by pecked grooves on which the north and south walls were erected.

Room 75 lies east of room 74, in the lower northeast portion of the cave. Most of its west wall still stands and the lower half of this bears traces of plaster. The north side, now missing, stood upon a well-marked groove; the south wall, also missing, had been built on the very edge of the cliff. Of the east wall a small section found in position rested upon several inches of loose household rubbish.

The north half of the floor had been worked out of native rock, while the remainder was filled in and adobe surfaced. Pecked in the standstone near the east wall is a shallow hole, 2 inches in diameter; just below it is a step that may have been cut before the house was built. A stone in the outer east wall bears an incised, swastika-like design. (Fig. 4.)

In 1917 we partially restored the north and east walls. (Pl. 22, B.)

Room 76 was built on the sharply inclined cave floor between rooms 75 and 77. A pecked groove marks the former position of its south wall; its east and west sides, now represented by a few courses of masonry, had been erected upon loose débris. We saved the west fragment by building in new foundations as the rubbish was removed; the north end of this same wall and the east side were partially reconstructed.

Room 77 is a small chamber between room 76 and the retaining wall in the upper northeast section of the cave. Its missing south

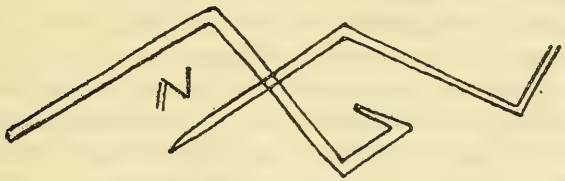


FIGURE 4.—DESIGN INCISED ON OUTER EAST WALL OF ROOM 75

wall formerly stood upon a narrow, pecked groove; a worked-out area marked its floor level. The east and west walls, having disintegrated beyond hope of repair, were partially restored in 1917, as was also the adjacent retaining wall. (Pl. 20, B.)

Room 78, also in the upper east end of the cave, was designed for storage purposes. (Pl. 19, A, B.) Sheer cliff forms its northeast wall; masonry, the others. Externally the stonework of this room is among the best in the ruin; inside it is crude and irregular. The level floor is wholly of native rock. Four beams supported the roof; two of these, of aspen and still present, lie side by side next the cliff.

Thirteen inches above the floor in the middle northwest wall is a 15 by 24-inch (0.38 by 0.61 m.) door, whose heavy stone lintel is supported by five strips of split cedar. The outer jams and lintel of this entrance are deeply grooved for the door slab so typical of Betatakin storerooms. In the southeast wall, 22 inches (0.56 m.) above the floor, one notes a former opening that measured about 16 by 20 inches (0.40 by 0.51 m.). Its irregular sides and the absence both of lintel and sill slabs suggest that this prospective door

was broken through after completion of the room and then closed again before it was actually finished.

Rude masonry, 2½ feet (0.76 m.) high, caps the southeast wall; through this a single beam end protrudes from room 79.

Room 79, a dwelling, stands southeast of and next to room 78. Its ceiling of cross poles, willows, and Johnson grass rested upon two northwest-southeast beams. But the roof had been crushed by large sandstone slabs, fallen from the vaulted cave. (Pl. 21, A.) The northeast wall is cliff; the southwest, of wattle—willows and Johnson grass bound to posts and surfaced inside and out with adobe. No plaster appears on the other three sides; all four are heavily smoked. The northeast half of the rock floor has been pecked out to a depth of 12 or 14 inches (0.30–0.35 m.); a 3-inch fill covers the remainder.

A door opened through the middle southwest wall with its adobe sill at the outside terrace level, 4 feet 3 inches (1.3 m.) from the retaining wall. Just inside this door is a platform, 4 inches high; at its southeast side a slab on edge, 10 inches (0.25 m.) high by 13 inches (0.33 m.) wide, abutted the wattled wall and a now missing masonry firescreen. Against the northeast base of this former screen one notes a slab-lined fireplace, 23 by 11 by 7 inches deep (0.58 by 0.27 by 0.17 m.). On a narrow ledge in the east corner, 3 feet 6 inches (1.06 m.) above the floor, lies a boat-shaped shelf measuring 5 by 12 inches (0.127 by 0.305 m.), made of adobe and chinked with small sandstone chips. The stonework blocking the unfinished opening into room 78 was laid flush with the northwest wall face.

Room 80 will also be found at the upper east end of the cave, between rooms 79 and 81. Its ceiling height may not be determined, for the upper northwest and southeast walls were broken by great slabs falling from the cave roof. The northeast wall is formed by the cliff; the now missing southwest wall, of wattle, stood 4 feet 6 inches (1.4 m.) from the retaining wall. The adobe floor, spread over a shallow fill, lies 3 inches below the outside terrace level. In the west corner of the room is one stone of the former slab-lined fireplace.

Room 81, adjoining room 80 on the south, also was utilized as a dwelling. Like its neighbor, its northeast wall consists of the sandstone cliff; its southwest wall, now missing, was of wattle. The rock floor at the northeast had been slightly reduced by battering; on the opposite side two grooves evidence the whetting of stone axes. A door undoubtedly opened through the wattled southwest wall.

The retaining wall which forms a terrace fronting this and nearby dwellings stands 2 feet 6 inches (0.76 m.) from the south corner and 4 feet 3 inches (1.29 m.) from the west corner of room 81. On

the cave floor just south of this room are two grooves where axes were sharpened. Here the cliff drops sharply away, perhaps 25 feet (7.62 m.), to rooms 83–85; down this slope débris had been thrown from the upper dwellings.

Room 82 stands on the cliff edge in the lower east part of the cave. (Pl. 21, B.) Its east wall is of wattle; the others of masonry. All four walls were plastered their full height; all are heavily smoked. The ceiling beams lay north and south.

A door with the usual slab sill divided the wattled east wall. Against each inner jamb stands an upright slab, that at the north being 18 inches (0.45 m.) high by 18 inches wide; that at the south, 7 inches (0.17 m.) high by 22 inches (0.56 m.) wide. These appear to have abutted a slab fire screen, now missing. A fireplace, 18 inches (0.45 m.) square by 8 inches (0.20 m.) deep, lies 2 feet 6 inches (0.76 m.) from the east side. In the middle south wall, 3 feet (0.91 m.) above the floor, is an 8 by 11 inch (0.20 by 0.27 m.) opening whose outer dimensions are reduced to 4 by 10 inches (0.10 by 0.25 m.).

Our 1917 efforts included repair of the wattled east wall and replacement of the adjacent ceiling beam (pl. 22, B); miscellaneous patching and resurfacing of the three masonry walls; restoration of the fireplace and partial reconstruction of the north wall as a support for an extramural platform or walk, 2 feet (0.60 m.) wide and 3 feet (0.91 m.) above the room floor.

Court 83 lies between rooms 82 and 84, on the cliff edge in the lower east end of the cave. Its south wall was relatively low; opposite this the cliff slopes down to form part of the court floor, the remainder being filled with débris and surfaced with adobe a few inches above that of room 82. A fireplace, 19 by 23 inches (0.48 by 0.58 m.) by 8 inches (0.20 m.) deep, lies against the middle southeast wall. At each end of this wall a single step had been cut into the masonry. In the north corner a series of four pecked steps leads to the platform between room 82 and the cliff.

We repaired the wattled west wall by tying horizontal willows to those still standing between the posts; no plaster was added.

Room 84, a storeroom, adjoins court 83 on the southeast. All four walls are of masonry; that at the northeast stands on a narrow ledge, 3 feet 6 inches (1.06 m.) from the cliff, the space between being filled with débris. Two ceiling beams support nine cross poles with layers of willows and cedar bark. On the northeast side is a 16 by 20 inch (0.40 by 0.51 m.) hatchway, once covered by a door slab; in the masonry beneath this opening are three pecked steps. No wall pegs are present. The most unusual feature of this granary is the fact that it is floored with sandstone slabs, set in adobe mud.

We replaced the stone slabs that rimmed the ceiling hatchway.

Room 85, another storage chamber, adjoins room 84 on the southeast and stands on the very edge of the cliff, at the base of the precipitous slope below rooms 78–81. (Pls. 21, B; 25.) Two parallel ceiling beams near the outer wall and a third next the cliff support seven cross poles with superposed layers of willows and cedar bark. No wall pegs were noted. Like its neighbor on the northwest the room was entered through a 16 by 20 inch hatchway. Beneath this opening two steps were pecked in the cliff. The northeast half of the floor consists of native rock, sloping and uneven; the remainder is paved with slabs set in adobe.

On the roof between rooms 84 and 85 and next the cliff is a slab-lined fireplace measuring 13 by 27 inches (0.33 by 0.68 m.) by 8 inches deep; it is rimmed by slabs and surrounded by an adobe pavement.

We placed two posts in this chamber to support a broken cross pole and the northeast beam.

Room 86, under the cliff at the lower southeast end of the cave, has not been excavated. It is represented by several wall fragments, mostly concealed by rocky débris.

Room 87, also unexcavated, abuts the north corner of room 86. It is filled with large rocks; between these one notes the jamb of a north door. We observed no evidence of the curved west corner shown on Douglass's plan.

Room 88 is a small storeroom, adjoining room 87 at the base of the southeast cliff. Its fragmentary walls disclose no trace of beams; its entrance was probably a ceiling hatchway. A rock ledge on the east cliff about 3 feet (0.91 m.) above the floor forms a shelf 3 feet 6 inches by 4 feet 6 inches (1.06 by 1.4 m.).

On the cliff above one notes a 26-inch circle, painted in dull red except for the upper left quarter. Near this is an indistinct white spiral 3 inches (0.07 m.) in diameter. At the outer southeast corner a rock contains five deep grooves where axes were sharpened.

The space between rooms 88 and 89 has not been excavated. There are no visible indications of a west wall. Smoke stains on the cliff suggest a probable open fireplace.

Room 89 served as a dwelling. Vertical cliff forms its east wall; masonry, the others. Its floor is of native rock, pecked out to a depth of 6 inches (0.15 m.) in the southeast corner.

Part of one jamb places a former door in the middle south wall. Just within the room, 5 inches (0.13 m.) below the door sill, stone slabs form a step 2 inches (0.05 m.) high; close on the west is a slab-lined fireplace measuring 14 by 24 inches (0.35 by 0.61 m.) by 6 inches (0.15 m.) deep. In the west wall at the southwest corner a blocked

door, 12 inches above the floor, measured 19 by 22 inches (0.48 by 0.56 m.); its protruding lintel slab formed a shelf 4 inches (0.10 m.) wide by 22 inches (0.56 m.) long. Below the sill and next the south wall is a ventilator, 8 inches (0.20 m.) square, apparently cut through after the door was blocked.

On the cliff above the former roof level is a white painted figure which Cummings (1915, p. 277) identifies as a "Slayer god"; near by, a typical Pueblo conception of a mountain sheep. (Pl. 29, A.)

Room 90, occupying a narrow ledge north of room 89, was utilized for storage purposes. Of its walls only a few courses remain. At the north end two beam rests had been pecked in the cliff 3 feet 6 inches (1.06 m.) above the ledge surface; no others were noted.

On the same ledge, but north of room 90, three grooves were worn by patient sharpening of stone axes. Two shallow steps, without apparent purpose, are noted on the cliff face.

Room 91. Only a small fragment of the north wall remains. The room is still unexcavated; undisturbed and much-weathered rocks lie at the southeast, close below the northwest corner of room 90.

It seems doubtful that this room could have been so large as Douglass represents or that the retaining wall he shows could have extended all the way to room 94.

Room 92 lies below and slightly south of room 85, on a narrow ledge which has settled outward 10 or 12 inches. The west wall, built on the terrace edge, has fallen; sheer cliff forms the north and east sides. A pecked beam rest may be noted in the north wall, 6 feet (1.82 m.) above the floor; on the adjacent cliff one observes the marks of rubbed implements and numerous daubs of variously colored mud, but no smoke stains. Near by, just above the south wall, is the white imprint of a small hand. The room floor is the unworked ledge surface. A door opened through the south wall at the southwest corner.

Room 93, a small dwelling, was built south of room 92 and on the same ledge. The north and south walls are of masonry; the west has disappeared. Smoke stains are discernible. The south half of the floor had been pecked down to a depth of 23 inches (0.58 m.); in the face of this cut, under the south wall masonry, are two vertical grooves about three-fourths of an inch wide. Marks left by sharpening of stone tools show plainly in the rock floor.

A north door gave access to room 92; near by a circular fireplace, 19 inches (0.48 m.) in diameter, was pecked into the ledge surface. From the near door jamb a masonry wall extended to the east cliff, forming a triangular bin in the northeast corner; against the inner face of this wall is a thin, upright slab.

Room 94. No walls are now visible, but seven pecked beam rests appear in the east side, below the ledge on which room 92 stands.

There are no similar seatings on this same bench face below room 93, which fact, together with the presence of large rocks, suggests that unexcavated room 94 is smaller than Douglass has indicated.

Room 95 is a dwelling on the same ledge with, and south of, room 93. Its north and south walls are of masonry; the west has vanished. Traces of smoke adhere to all standing walls. The ledge surface had been pecked down to a depth of 22 inches (0.56 m.) at the northeast and 27 inches (0.68 m.) at the southeast, but the west side of the floor was filled in. Near the west end of the south wall is the east jamb of a former T-shaped door, the only one observed in Betatakin. Its upper portion, about 20 inches (0.51 m.) high, is set back 4 inches (0.10 m.) from the lower, 13 inches high. A protruding rock east of this door had been partially severed with stone saws.

Just within the door is a platform, 23 inches (0.58 m.) wide by 10 inches (0.25 m.) high; at its north side stands a masonry fire screen, 10 inches (0.25 m.) thick, 3 feet 5 inches (1.04 m.) long and now 21 inches (0.53 m.) high. Pecked in the rock floor at the north base of this screen is a fireplace measuring 13 by 18 inches (0.33 by 0.45 m.) by 7 inches (0.17 m.) deep. Three feet 5 inches from the north wall and 37 inches (0.94 m.) from the cliff a pecked hole, 3 inches (0.07 m.) in diameter by 2¼ inches (0.05 m.) deep, contains a single stick as a loom anchor.

A large rock lies south of room 95 and beyond it is space for two rooms. The ledge surface here has been leveled by battering with hammerstones, but no beam rests appear in the cliff and only one masonry wall fragment, at the southwest corner of the floor area, is evident. Daubs of colored mud had been thrown against the cliff; here, also, is a rudely painted white square with sides 2 inches wide and, high above, the rude representation, also in white, of a mountain sheep.

Room 96. Visible wall fragments on the talus below the two probable chambers on the ledge south of room 95 suggest a former irregular retaining wall extending to the outer southwest corner of room 94. This section remains unexcavated.

Room 96 is the last indicated on the Douglass ground plan. In 1917, however, while clearing Betatakin of débris preparatory to our work of repair, a number of additional structures or traces of them were disclosed in the cave proper. These we have numbered 100 and following.

Room 100, lying between rooms 27 and 29 and entered from court 28, could have answered only for storage. Its north wall is the face of a cliff terrace, with superimposed masonry; its floor is of native rock, seamed and uneven. Three northwest-southeast beams support eight aspen cross poles with layers of willows, Johnson grass,

and sand. The roof lay in continuation with the floor level of court 34.

A section of the smoke-stained northwest wall of room 29 extends through into room 100; the upper portion of this protruding masonry had been raised somewhat to form an 8 by 20 inch (0.51 m.) shelf, 22 inches (0.56 m.) above the floor. Below this shelf is the embedded end of the lower log supporting the northwest side of room 29. Through the middle southeast wall a 15 by 23 inch (0.38 by 0.58 m.) door opens into court 28. Six small aspen branches support the stone lintel; its sill slab lies about 12 inches above the floor.

Room 101 will be found in the north middle portion of the cave, adjoining room 64–65. Only a portion of its northeast wall remained in 1917, and this was so disintegrated and so insecure we partially replaced it with new masonry, built upon deepened steps. The southeast wall had rested on two rather shallow steps, slightly north of the southeast corner of room 64–65. Other pecked steps, varying in size and depth, are present on the abruptly sloping cave floor in front of and below rooms 101 and 102. (Pl. 16, B.) While some of these doubtless served as wall rests, it is quite possible the others merely furnished temporary footing for the builders.

Because the space between it and the slanting cliff is so restricted, the southeast wall rose several feet to the floor level. This space may have been filled with débris or it may have served for storage purposes. Above it, however, there must certainly have been a living room, corresponding with that next on the west.

An old step series leads northwesterly up the sloping cliff, across the middle of room 101 and the upper end of room 64–65, to room 63.

Room 102. Of this room, northeast of and adjoining room 101, no walls remained in 1917. But their former positions were plainly evident from the pecked steps and grooves commonly used as rests for masonry. The southeast wall formed a continuation of that in room 101. High on the upper slope great slabs of sandstone have separated from the ledge. Since these slabs are grooved by the grinding of stone axes we endeavored to hold them in place by several steel drills, set on the lower side.

It is improbable that other rooms formerly stood on the sloping cave floor northeast of room 101, but disintegration here has removed all trace of them, if any.

Rooms 103–106. Four buildings northeast of rooms 49 and 50 and northwest of room 47 may be postulated. With but few interruptions a pecked groove continues from the west corner of room 55 to the north corner of room 50; this undoubtedly once served as a wall rest. A similar groove, extending from the north corner of room 46 to the east corner of room 52, is supposed to be that on which the

northeast walls of room 49 and 50 once stood. Other wall seatings in this section are less certain.

Room 107 stood next on the east of room 53, but our excavations exposed only a single fragment of its northeast wall. This abutted the southeast side of room 101 near the outer east corner of room 64–65. Subsequently we restored this small section. (Pl. 15, B.) The former position of the southeast wall has been lost with disintegration of the cave floor.

Rooms 108–109. A pecked groove and the apparently worked appearance of the disintegrated sandstone below rooms 101 and 102 suggests the former presence of two rooms no wall of which remained in 1917. Masses of adobe-covered grass flooring had slid down slope from rooms 64, 101, and 102, and were removed from this area during our preparatory excavations.

Rooms 110–113. Fragments of flooring in place above the north wall of room 55 indicated the former presence of dwellings, but we observed no pecked holes or grooves that would serve to mark the position of masonry walls. There had been much seepage throughout this portion of the cave with resultant disintegration of the sandstone; blown sand had lodged here and in it trees and shrubs had taken root. (Pl. 6, A.)

A narrow ledge between the steep, upper cave floor, and the probable north line of this room series marks the old trail which led past rooms 117 and 122 to room 73 and the upper east end of the village.

Rooms 114–115. The ledge face which formed the north wall of room 55, continuing to the eastward, underlay the south walls of two rooms whose respective floor levels are indicated by pecked-out areas. The floor of room 114 was approximately 2 feet (0.60 m.) below that of room 115. A portion of the east wall of room 115 remained in position; the other walls were not traceable in 1917.

Buried in the accumulated débris removed from this area was an infant's skeleton, the only burial we found.

Room 116. Disintegrated portions of the east and west sides were found, resting on steps pecked in the sloping sandstone. Although the south wall was missing, its former position was plainly marked by a groove along the cliff edge. Two other pecked grooves, apparently incomplete, extend northwestwardly up the slope from the southeast corner of the room. Fully 3 feet of débris against the inside south wall was necessary to complete the floor level, represented by a worked-out section on the cliff face.

Following excavation we partially reconstructed the fragmentary east and west walls.

Room 117, north of room 121 and northwest of room 66 in the middle north portion of the cave, was set aside for the grinding of

maize and other foodstuffs. When exposed by our excavations only sections of the north and west walls remained, and both these were covered by blown sand which had settled about the roots of trees. Pecked grooves identified both the east and south wall positions. Behind the north wall a débris fill marked the cross-cave trail heretofore mentioned. In the middle floor were three broken, slab-line mealing bins from which the milling stones had been removed.

In our work of repair we restored the lower walls of this room, rebuilt the grinding bins, and fitted them with metates recovered from other portions of the ruin. (Pl. 23, A.)

Rooms 118–119. Built upon the lowermost terrace and adjoining room 55 on the east was a room approximately 15 feet (4.57 m.) long, subsequently divided by a wattled partition. The fairly level, unworked ledge surface formed a floor several feet above that in room 55. The south and upper north walls had wholly disappeared. Incorporated in the north end of the east side is a projecting block of masonry, 21 inches (0.53 m.) long by 10 inches (0.25 m.) wide, the purpose of which remains unknown. When inhabited, the two rooms were doubtless connected by a door through the dividing, wattled wall.

Room 120 is situated in the lower, middle front of the cave between rooms 119 and 121. Portions of its north and west walls stand at the northwest corner; below these fragments the sloping sandstone has been slightly reduced. The room floor, however, was doubtless lower than this pecked area, and must have rested on a fill supported by the now missing south wall.

Room 121, a large dwelling, adjoins the west side of 2-story house No. 66. (Pl. 9, B.) The west and part of the south walls were missing; at the north, on the next higher terrace edge, masonry which we replaced in 1917 separated this structure from room 117.

In the southeast corner is a subfloor, masonry-walled fireplace measuring 3 feet 4 inches (1.01 m.) north and south by 22 inches (0.56 m.). Its west side had slumped with collapse of the southwest quarter of the dwelling. West of this fireplace the room floor had rested on a deep débris fill; sloping cliff, worked down in the northeast corner, occupies the north half of the room. Between the base of this terrace face and the fireplace and 16 inches (0.40 m.) from the east wall is a pothole pecked into the solid rock. It measures 10½ inches (0.26 m.) in diameter by 12 inches (0.31 m.) deep. In this hole we found the earthenware colander illustrated in Plate 46, 1, a charred hairbrush (pl. 39, 1), and a short mano. A door blocked with rude masonry formerly connected this dwelling with the storage chamber below room 66.

It is not unreasonable to suppose that rooms 118–121 were originally 2-story buildings.

Room 122. Obviously a later addition, this structure was built across the old trail on the sloping cave floor north of room 68. The north half of its floor area, of native rock, was worked down somewhat; the remainder consists of adobe mud spread over a débris fill. The masonry walls, which had entirely disappeared, were partially restored in 1917. (Pl. 24, A.)

East of room 122 and abutting the north wall of room 70 an artificial terrace forms a landing at the foot of the step series leading past room 73 to the upper east house group. Following construction of room 122 its roof may have been crossed by aid of ladders or the old trail may have been abandoned in favor of the pecked steps one notes higher up the slope.

Room 123 is situated on the front edge of the slope, east of room 71 and below the trail past room 73. Seatings for its missing walls are not at once apparent, but the rock surface has been battered away somewhat and still shows the stains of smoke and ashy deposits.

The rather precipitous cave floor between rooms 123 and 76 was mostly covered at the beginning of our work by large masses of sandstone, fallen from the cave roof. On this slope is space for at least six large rooms.

Room 124, in the upper east end of the cave, is evidenced by smoke stains and wall adobe adhering to the north, or cliff, side. Owing in part to seepage at this point the masonry has wholly disintegrated.

The narrow ledge extending west from this room would seem to have offered desirable house sites, yet no indication of masonry was found beneath the huge masses of sandstone we removed. (Pl. 20, A.) One might infer from this omission that at least part of the broken rock had accumulated prior to or during occupancy of this upper east terrace.

Room 125. Portions of the east wall were present; masonry which doubtless once rose to the ceiling level stood against the north, or cliff, side. The south wall appears to have been of wattle; through it a door must have opened upon the artificial terrace above room 77. Next the cliff the rock surface had been worked down to a uniform floor level.

In front of room 125 is a narrow walk, supported by a retaining wall which meanders from this point to the cliff beyond room 81. (Pl. 19, B.)

Room 126 lies between rooms 125 and 127. The masonry of its east and west walls abuts the cliff; the south wall is of wattle with a door in the middle. At the base of the cliff a masonry bench, 15 inches (0.38 m.) wide by 17 inches (0.43 m.) high, extends the entire width of the room. The artificial floor lies 8 inches (0.20 m.) below

that of room 125; in its middle is a slab-lined fireplace. Three of the slabs bordering this pit extend 5 inches (0.13 m.) above the floor level.

Room 127. The east wall of this dwelling had been demolished by falling blocks of sandstone and wholly disintegrated by seepage. But smoke stains on the cliff indicate a room larger than those immediately to the west. Portions of the west and wattled south walls were present; against them lay broken flooring, 6 inches (0.15 m.) above the walk outside.

Between rooms 127 and 78 is space for two dwellings, but the level terrace surface here, although smoothed with adobe, discloses no evidence either of masonry or wattled walls. The outer jambs and lintel of the door into room 78 are deeply grooved for the door slab characteristic of storerooms. At one side of this opening two pecked steps gave access to the roof.

Room 128 stood on a low detached ledge west of room 74. A cut-out area marks its approximate floor level and indicates the probable wall positions.

From above the northwest corner of this room pecked steps extend northward for several feet up the sloping cave floor, as seatings for a former wall.

Room 129 was built on the cliff edge in the lower east end of the cave, south of room 75 and west of room 82. The cliff face had been worked down in two terraces; the lower of these forms part of the floor, while the upper extends nearly the entire width of the room as a bench 9 inches (0.22 m.) high by 8 inches (0.20 m.) wide. The curved southeast wall, now reduced to 2 feet (0.60 m.) in height, follows the contour of the cliff. No beam holes are evident in the smoke-stained walls.

We repaired the north end of the curved wall, but did not attempt desirable restorations.

Room 130 is one of possibly six large rooms formerly situated on the abrupt slope southeast of room 73 and north of rooms 74 and 128. Pecked grooves and steps as probable wall seatings are noted at intervals, but it seems likely that whatever masonry once stood here was erected upon débris thrown down from dwellings above, as was the case east of room 76.

Rooms 131–135. Excavated areas approximating floor levels, with pecked grooves and steps as rests for masonry walls, indicate the former presence of six or more rooms in that section east of room 76 and north of room 82. At least some of these structures had been erected upon loose débris. No walls were standing in 1917. At beginning of our operations this entire slope was buried under fallen masonry; great blocks of standstone from the cave roof seemed largely responsible for the destruction.

A series of steps leads up the cliff from the northeast corner of room 75 to the retaining wall opposite the northwest corner of room 78 and was undoubtedly used before houses were built in this quarter. Above rooms 83–85 the cliff appears too precipitous for dwelling sites.

Lack of time precluded even partial restoration of the demolished buildings we have numbered 131–135. But we renewed the old step series from the northeast corner of room 75 down to the platform back of room 82, thus facilitating access to court 83 and its near-by storerooms.

Retaining wall. Rooms 78–81 and 124–127 stand on a level ledge at the upper east end of the cave. Erected upon a 2-inch groove, pecked on the outer edge of this terrace just where the cave floor drops abruptly down to rooms 82–85, is what we have called "the retaining wall." It is the counterpart of that which inclosed court 10 and continued southward to form the walk leading to room 3.

The east retaining wall widened the natural terrace and thus formed in front of the dwellings a walk that varies somewhat in width as it extends from room 81 northward to room 124. Opposite the south corner of room 81 this terrace walk is 2 feet 6 inches (0.76 m.) wide; at the south corner of room 80 it is 4 feet 3 inches (1.3 m.) wide; at the south corner of room 78, 4 feet (1.2 m.); at the west corner of room 78, 3 feet 9 inches (1.14 m.). Three slab steps, totaling 15 inches (0.38 m.) in height, connect the upper terrace level fronting rooms 79–81 with the lower level northwest of room 78.

We repaired and recapped the retaining wall throughout its greater length; rebuilt a missing segment above rooms 132 and 134 after widening and deepening its seating groove; omitted restoration of the extreme ends. (Pls. 19 and 20.) As noted under the description of individual rooms, certain minor repairs were also made on the houses hereabout.

Gallery wall.—In the high, upper portion of the cave, on the very edge of the cliff and about 25 feet (7.62 m.) above room 59, is a long straight wall approximately 4 feet (1.2 m.) high. Viewed from below, this wall appears to stand alone, but there is a bare possibility that other walls lie buried in the loose shale which has accumulated on the slope behind the wall. About 2 feet (0.60 m.) above the front base of the masonry 11 poles protrude to suggest a probable floor level behind the wall.

Access to the gallery was formerly gained by means of the long pine pole still standing at the north end of court 10. Only one who has shinned up this splintery pine and felt it tip threateningly outward from the sheer cliff can fully appreciate our lack of knowledge concerning the upper gallery and the structures, if any, it shelters.

BETATAKIN ARTIFACTS IN THE NATIONAL MUSEUM

The cultural plane attained by any primitive people is determinable in part by their habitations; to an even greater degree, by articles daily employed in and about those habitations. This truism holds not only for Indian tribes living in the United States a generation ago but also for those that passed on before the origin of what we commonly call the "history" of our country, beginning with the voyages of Eric the Red and Columbus.

It would be altogether unjust to the prehistoric builders of Betatakin, therefore, were I to attempt portrayal of their arts and industries from the few, miscellaneous artifacts recovered during the course of our work in 1917. These were all casual finds, disclosed as we cleared away the vast accumulation of detritus and household rubbish with which the ruin was blanketed. Alone, these chance objects tell an incomplete story. But they may add something to that history of the village which is yet to be written; hence, it seems desirable briefly to list those minor Betatakin antiquities now preserved in the national collections.[14] National Museum catalogue numbers accompany those specimens mentioned but not illustrated; the list on page 75 gives the numbers and dimensions of those shown by plate and text figure.

OBJECTS OF STONE

Metate (pl. 31, 1).—The only milling stone brought away was last used for pulverizing yellow ocher; a rubbed area on its under side is smeared with red paint. Of fine-grained sandstone, the specimen has a grinding surface transversely plane but longitudinally concave, being worn in the middle to a depth of five-eighths of an inch.

To judge wholly from want of contrary statements in my field notes, the characteristic Betatakin metate is relatively thin, rather carefully shaped by pecking with hammerstones, and rarely, if ever, deeply troughed.

Manos, or mullers (pl. 31, 2–5) are the hand stones with which maize and other foodstuffs were ground on metates. Among the 30 manos (312207–27) in our collection, certain dissimilarities of shape and size are obvious. This variation is owing to the structure of the sandstone, volcanic breccia, and vesicular quartzite from which all are made and, perhaps in equal degree, to personal differences in method of use. Eight of the 30 appear to be reworked and reused mano fragments; they vary in length from 4¾ to 6¾ inches (0.120

[14] Every specimen regarded as reasonably secure from the habitual curio collector was left at the ruin.

to 0.171 m.). The remaining 22 average 4¼ inches (0.107 m.) in width by 10¼ inches (0.260 m.) in length. Six of these are provided with shallow finger grips on the longer sides, while three only, and four of the shorter ones, show wear on both sides. Four of the series, all long mullers, are slightly wedge-shaped in cross section; three, including a reworked fragment, exhibit a convexity due to wear on a narrow, shallowly troughed milling stone. On the flat-faced metates of Betatakin, flat-faced manos naturally were employed.

Rubbing stones, supposedly for smoothing newly surfaced floors, walls, etc., bear a close relationship to the manos and might well have substituted for them upon occasion. Our three specimens of this type (pl. 32, 7–9) are all of sandstone, somewhat oval, carefully shaped at the periphery, rubbed on both faces. Water-worn cobbles frequently were carried long distances by Pueblo peoples living in a region of sand and sandstone. From Betatakin we brought two such cobbles (312231), both of which show slight use as smoothers. One is of quartzite; the other, diorite.

Six small pebbles (312232), worn smooth by stream action, were used to polish the thin clay slip with which earthen vessels were surfaced. Such pebbles were the handy tools of Pueblo potters in middle and late prehistoric times.

Two still smaller pebbles of white flint (312310) are flattened on one or more sides. Similar specimens have been found heretofore in a medicine man's outfit.

Hammerstones.—Any hard, tough stone served as a hammer. Of the three in our series (312233), two are quartzite cobbles polished by blown sand before human use; the third and largest (pl. 32, 6) is of chert.

Mauls.—Our two mauls are each provided with an encircling groove for attachment of the customary withe handle. The larger, of heavy sandstone, is flattish and irregular, but evidences considerable work with the pecking hammer. (Pl. 32, 4.) In marked contrast, the second is merely an elongate basalt cobble (312240), grooved about the middle and probably used but once or twice.

A much smaller and more globular specimen (312241), of vesicular quartzite,[15] while maullike in shape may have been intended as a weapon. There can be little doubt, however, that the one shown in Plate 32, 5, was designed as a club head, for it was carefully pecked then smoothed with a sandstone rasp. Its pointed ends, slightly battered on other rocks, illustrate the readiness with which almost

[15] A seemingly porous material containing variecolored stone pellets and described by the late Dr. George P. Merrill, head curator, Department of Geology, U. S. National Museum, as "a very interesting and peculiar type of quartzite."

any Pueblo implement was pressed into service for which it was not primarily intended.

Stone axes (pl. 32, 1–3).—The four recovered, all of diorite, are relatively crude, like most axes from ruins throughout the San Juan drainage. The smallest of those illustrated has a secondary groove just below the principal one.

Celt.—The well-known celt or *tcamahia* of the San Juan Basin is represented by a single, fragmentary specimen of reddish argillaceous chert (312243). Its handle is mostly missing, but on the remaining portion a perceptible difference in coloration indicates the former presence of a covering or wrapping. The blade had been broken, rechipped, and the sharp edges slightly rubbed.

FIGURE 5.—WOODEN KNIFE HANDLE

Chipped implements.—Of the six flint points at hand (312312), two are arrowheads. The smaller of these, triangular in shape, is three-quarters of an inch long; the other, notched and slightly barbed, measures 1¾ inches. The other four specimens may be regarded as knives. Their bases are square or nearly so, and to two of them some adhesive, probably pitch, still cleaves. The largest of the lot, its tip missing, measures 1 by 2½ inches (0.025 by 0.063 m.); its sides and edges have been slightly smoothed by rubbing. The wooden knife handle illustrated by Figure 5 was collected at Betatakin by Professor Cummings in 1909 and added to the national collections through exchange with the University of Utah.

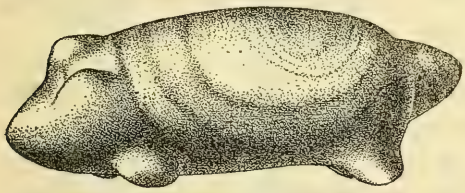


FIGURE 6.—STONE EFFIGY

A small fragment of a red jasper flake (312313) had been chipped along each side, for use in cutting or scraping.

Stone pellet.—A rounded stone ball (312309), five-eighths of an inch in diameter and blackened by fire, served an unknown purpose.

Effigy.—No one may say what animal is represented by the little stone effigy shown in Figure 6. Its front legs, mere knobs at best, have been broken and subsequently rounded.

Turquoise.—The fragment of a small, semilunate bead, V-drilled on the flatter side, is the only piece of turquoise collected (312311).

Pendant.—The only undoubted ornament we recovered is a thin disk of red clay stone (312304), drilled at one edge for suspension and in the middle for diversion.

Lignite ornament (fig. 7).—Through a ridge across the middle back, two V-drillings provided means of attachment. On one edge are four vertical and parallel incised lines. The material is lignitized wood, highly resinous.

OBJECTS OF WOOD

For working wood, the inhabitants of Betatakin had only flakes and chipped knives of flint; they used sandstone for rasping and smoothing.

Board (pl. 33, 1).—The specimen illustrated is an oak board, carefully finished but subsequently burned. Through one corner is a nearly vertical, drilled hole; on the same side and at approximately one-third the total length is a similar hole, bored at an angle of 55°. The two fragments which compose this specimen were found widely separated, the larger on the surface; the smaller, buried in the sand above room 55. Hence the difference in coloration seen on the original.

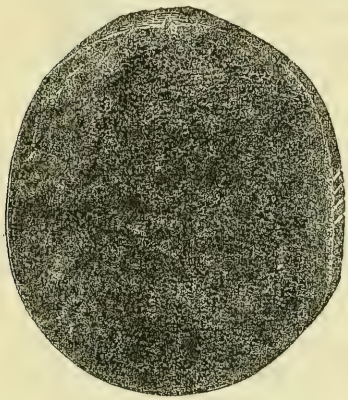


FIGURE 7.—LIGNITE BUTTON

A small, charred fragment of a like board, of cottonwood, is also drilled through one corner; the flatter side is deeply scored by cutting tools (312346).

Billets (pl. 33, 2–4).—Three cottonwood billets, or lapboards, and fragments of two others (312343) are in the collection. Two of the five still possess the original convex curve of the tree trunk, although slightly modified; all exhibit on their flat sides and rounded edges the marks of cutting and scraping implements or the pricks of some sharp-pointed tool. The longest of the three illustrated was made from a cottonwood root; all the others are from sections of the stem.

Digging sticks (pl. 34, 4–7).—Nine reused fragments of oak digging implements are all we found. For fuller understanding of these essential tools of primitive agriculture, reference should be made to Kidder and Guernsey (1919, p. 119) and other authorities.

In addition there is the problematical specimen shown in Plate 34, 1. Doubt hangs upon this latter from the fact that its pointed end is rounded and blunted, not flattened and sharpened as is always

the case with serviceable digging sticks. Conjecture might identify this as the oak staff or cane of some venerable villager.

Staves.—What seems unquestionably a walking stick is that illustrated in Plate 34, 2. Except for smoothing a few knots and trimming the two ends, no specialization is evident. The stick is cottonwood; its grip is worn and the lesser end rounded and abraded. Fragments of a like staff (312327) show a hole drilled transversely through the handle and, at the opposite extreme, the asymmetric wear such as one frequently notes on canes used by elders.

A third cottonwood staff (pl. 34, 3; fig. 8) differs from those just considered in that its lower end is circled by 14 incised grooves. Some of these were

FIGURE 8.—CARVED END OF COTTONWOOD STAFF

FIGURE 9.—DETACHED BOW END

FIGURE 10.—ARROW FORESHAFT

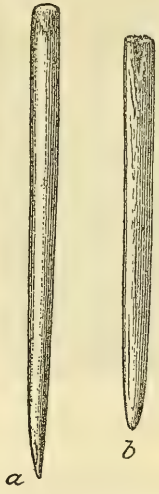


FIGURE 11.—SMALL WOODEN AWLS

made before, others after, an 11-inch splinter was cut away and its place gouged out. Except that the incisures circle its smaller end, this particular specimen might be likened to the so-called "ceremonial staves" occasionally found in Pueblo ruins.

FIGURE 12.—SPATULATE IMPLEMENTS OF WOOD

Bows and arrows.—In the collection are three fragments of two self bows, each made of red cedar (312331). The fragments are burned and blunted from use about a fireplace, but they show careful workmanship and a grip that measures 1¼ inches wide by $\frac{13}{16}$ inch in thickness. Figure 9 shows the severed end of a third bow.

Four wooden foreshafts for reed arrows (312360) average 8½ inches (0.215 m.) long; they are all shouldered and the two unbroken have plain, sharpened points, as does that from a shallow cave near Betatakin. (Fig. 10.)

Fire-making tools (pl. 35, 5, 9).—Three drills, two of them broken, and fragments of two cottonwood sticks with charred sockets identifying them as hearths, constitute all the fire-making apparatus we found in Betatakin.

Awls (pl. 36, 5–11).—The collection includes nine wooden awls measuring from 6¾ to 10⅜ inches (0.171–0.263 m.) in length. Their butts are rounded or flattened and square cut; none is spatulate. While two or three appear to be of red cedar a harder, more durable wood was preferred. Two smaller examples (fig. 11) are probably to be classed in this group.

Toothed implements (pl. 37, 1–5.)—Our five examples are all of red cedar. Two of them (2–3) have spatulate or knifelike butts;

1, cut from a splinter, is less carefully finished. It will be noticed that the number of teeth varies. The split and reworked edge of 2 indicates at least a former fifth tine, while the two fragmentary specimens apparently had 10 or more teeth each, and these were closer together, longer, and more rounded than in the others illustrated.

Knives.—Red cedar, of course, will not take an edge capable of cutting hides or equally resistant substances. But the two spatulate objects shown in Figure 12 have knifelike edges, and these are stained with what may be blood. Kidder and Guernsey (1919, p. 120) have called such instruments "skinning knives" under the quite logical assumption that they might have served in flaying animals.

The unfinished specimen represented by Figure 13 is included here only because its two ends are ground to near-cutting edges. Both sides are scored by the coarse sandstone rasp employed in the final shaping process.

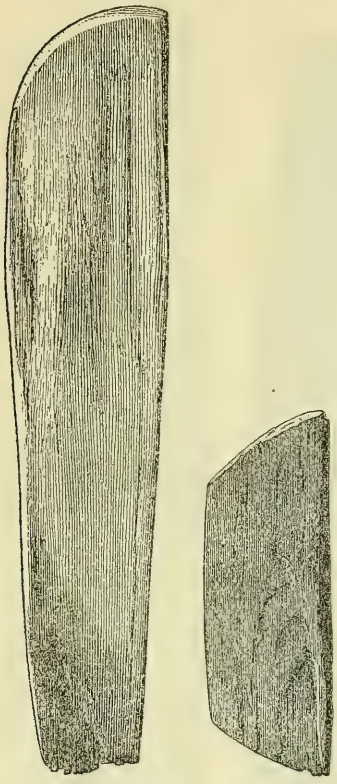
Paho (pl. 35, 1).—This cottonwood cylinder bears such a close resemblance to similar objects associated with certain Hopi rituals as seemingly to justify the designation. Its upper end is twice grooved, but displays no evidence of wear owing to cord attachments. A slight depression at this extremity is quite fortuitous, but in the base is a central, drilled concavity five-sixteenths of an inch in diameter by three-sixteenths inch deep.

FIGURE 13.—SPATULATE WOODEN IMPLEMENT, UNFINISHED

FIGURE 14.—SECTION OF WOODEN FLUTE (?)

Flute (?).—Large wooden flutes were employed by prehistoric as by historic Pueblos. But all modern flutes examined by the writer have been made in two parts, each gouged out in perfect agreement with the other and the two fitted together with exactness. The fragmentary specimen in hand (pl. 35, 3; fig. 14) must have been

produced by like means, for its inner surface is finished with such nicety; is polished and blackened so uniformly as to preclude use of any method of drilling known from the Southwest. Both edges are split. There remains no evidence of drilled holes; no trace of wrappings. Yet the fragment is almost certainly part of a large flute. The 14 external grooves were incised with flint flakes or knives.



a *b*

FIGURE 15.—WOODEN SCRAPERS

Scrapers (fig. 15, *a–b*).—The usual number of pine and cedar splinters employed in smoothing and scraping operations is in the collection.

Mask attachment (?).—A stopper-like object of cottonwood (fig. 16) is one of several specimens whose original function may only be surmised. Two cotton strings, projecting from a hole drilled through its lesser diameter, appear to have crossed the larger in the groove indicated.

Painted stick.—A cylindrical piece of wood, probably willow, $\frac{7}{16}$-inch (0.011 m.) in diameter by 1¾ inches (0.044 m.) long, covered with thick, dark green paint (312299).

Drill.—It is incredible that the crude drill shown in Plate 36, 1 and Figure 17, *b* was the tool of a skilled artisan. Its rudely chipped, chert point is set in the split end of a greasewood shaft and loosely bound with a shred of yucca leaf. A second drill, comparable in crudeness but less worn, is mounted in a reed shaft. (Fig. 17, *a*.)

Spindle shafts and whorls (pl. 36, 2–4; 12–16).—Spindle shafts are invariably made of some hardwood that takes and holds a smooth, even finish. Our longest (312363), a fragment, measures ¼-inch in diameter by 23⅜ inches (0.006 by 0.59 m.). Such slender, pointed shafts as 2 seem altogether too fragile for spindles.

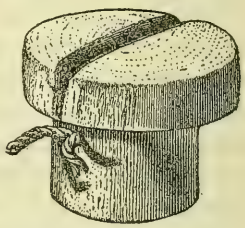


FIGURE 16.—WOODEN OBJECT

Six whorls, mostly cottonwood, vary in diameter from 1½ (0.038 m.) to 2 inches (0.050 m.); in thickness, from ⅝ (0.015 m.) to $1\frac{5}{16}$ inches (0.033 m.). The finest (13) is convex on one side; flat and centrally cupped on the other. One fragmentary specimen (312287) is convex on

both sides. Two (15–16) are of mountain-sheep horn, as is the squared block, a doubtful whorl, shown in Plate 36, 17.

Miscellaneous wooden objects.—We have the usual proportion of peeled and unpeeled sticks with cut ends; fragments severed from finished implements; slender, smoothed twigs with one pointed end; worked objects of unknown use (pl. 35, 6–8); splinters and twigs with sinew or cord wrappings (pls. 35, 2; 37.6–9).

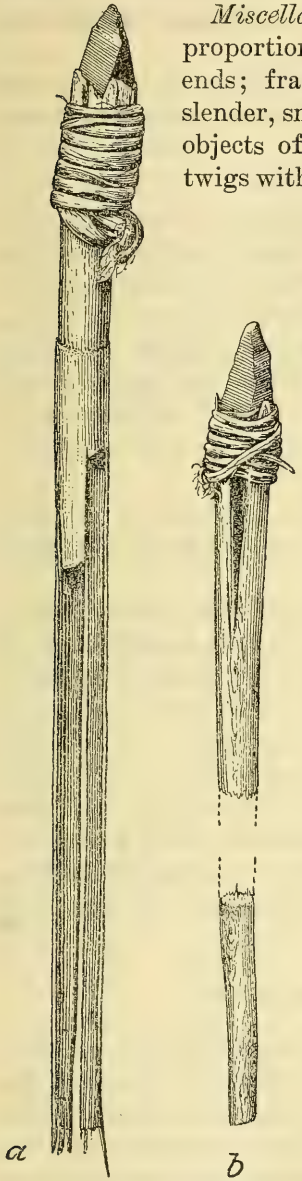


FIGURE 17.—DRILLS

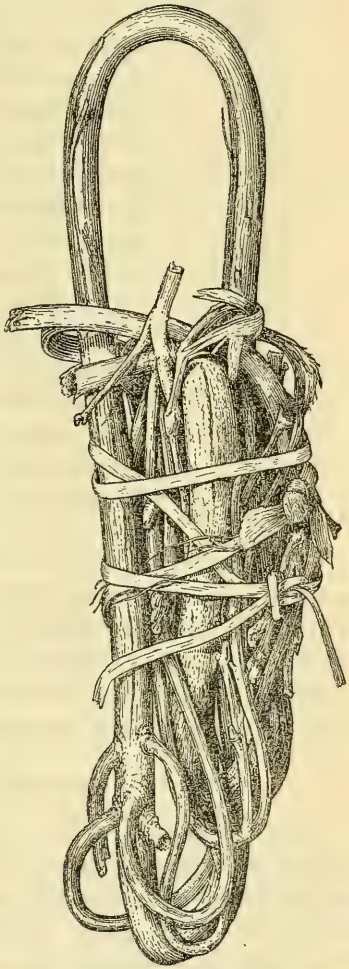


FIGURE 18.—LOOM ANCHOR

The oak stick pictured in Plate 35, 4 has been split to permit insertion of a scrap of cotton cloth; a wrapping of some sort formerly circled the stick and covered this fragment. The willow

rings shown in Plate 34, 8–9 may be regarded as hastily improvised potrests. A charred oak stem (312328) with four branches, the two unbroken having rounded tips, could have served as a vertical support for hanging various articles.

Figure 18 shows a not uncommon type of loom anchor—an oak branch, knotted and tied with yucca, and buried so that the loop lay just below the floor level.

OBJECTS OF BONE

FIGURE 19.—BONE NEEDLE

Awls (pl. 38, 1–8).—Of the 11 awls in our collection, only one (1) is of bird bone, and that the tibiotarsus of a turkey. The longest (2), with its specialized point, and the two rounded specimens (7–8), are worthy of note; the others are mere splinters and cut sections of mammal bones, shaped by abrasion on sandstone. Figure 19 illustrates a needle whose drilled eye is so small as to take but a single yucca fiber.

Fleshers.—The three typical examples in Plate 38, 9–11, are all of deer bone, the larger two from the femur.

Miscellaneous bones.—From almost every Pueblo ruin come diverse bones and fragments, many of which show at least some slight evidence of modification by human agencies. Only two such pieces were retained from the Betatakin excavations: (1) The humerus of a turkey from which both condyles were removed (312377), and (2) the cannon bone of a deer (312381), partially split by sawing on each side with flint tools. In addition, there is an unworked fragment of mountain-sheep horn (312382). A drilled block and two spindle whorls of horn were noted in a preceding paragraph.

OBJECTS OF VEGETAL ORIGIN

Brushes (pl. 39, 1–3).—The three specimens illustrated are composed of what appears to be cedar bark, completely charred (1), trimmed yucca leaves (2), and wire grass (3). Each is tied with a shred of yucca leaf. Brushes were employed in combing one's hair and in sweeping floors and, often enough, the two ends of a single specimen served these two entirely unlike purposes.

Cordage.—As is well known, most cliff-dweller cord was made of yucca fiber, that handy material so generously distributed throughout the greater part of the Southwest. The bundles figured in Plate

39, 4, 5, are of an unidentified species of apocynum and yucca, respectively. A second hank of yucca cord is embedded in a bit of adobe flooring, marked by the imprints of willow (312257). In addition, we have the usual number of scraps of feather-wrapped yucca cord; a tasseled fragment, square braided, of eight 2-ply cotton strands (312272); several cord fragments made from human hair (312275); a bit consisting of two strands of hair twined with one of yucca fiber (312274); and several knotted scraps of twisted buffalo hair (312281).[16] Bundles of human hair, tied with yucca shreds and perhaps intended for use in cord manufacture, or for weaving bags and other fabrics, are also in the collection.

Mats.—From the Betatakin cave débris came a small section of cedar bark matting, bound with a simple over-and-under lacing of yucca leaf shreds (312321); a similar fragment composed wholly of yucca leaves (312409) and several pieces of a larger mat, twill woven of rushes (312395).

Cloth (pl. 39, 6–9).—Bits of cotton fabrics, often patched and repatched, are present in nearly every cliff-dwelling rubbish heap. Most of these rags show a plain checkerboard weave, although their component threads may vary in size and compactness. Our rag series includes four specimens of twilled work (312259), two of which appear to be fragments of headbands, and a cotton tassel whose cord, seven-sixteenths inch in diameter, consists of a core of cloth strips inclosed by a covering in which three parallel strands were braided as one.

Our only example of twined textile is woven of human hair. A single specimen of coiled work without foundation has what appears to be buffalo hair twisted in with some species of apocynum fiber.[17]

Sandals.—Two types of weaving, twilled and wickerwork, are represented in the 11 sandals or sandal fragments we collected at Betatakin. Of the former, there are but two examples, both made from narrow yucca leaves. (Pl. 40, 1, 3.) The larger is the finer and more tightly woven; its component elements were plaited over-two under-two until the edge was reached, when each strand was tightened, drawn forward under-four, and reintroduced from the lower side, thus creating a slightly thicker, rounded selvage. As the weaving progressed from toe to heel, leaf ends were brought out on the sole, there to be clipped and later frayed through wear into a

[16] Kidder and Guernsey (1919, p. 118) note the finding of a scrap of buffalo hide, with the hair still on, in their ruin 7 and point out the possibility of its having been brought in by Navajos. Biologists have not yet included the Kayenta district in the known, former range of the mountain buffalo.

[17] A similar scrap (303262) in the Betatakin series obtained through exchange with the University of Utah includes both cotton and apocynum strings in which is twisted whitish mammal hair, as yet unidentified, that may be either deer or mountain sheep, and also the brown hair of some undetermined animal.

fibrous pad. (Pl. 40, 2.) To complete the weaving, each strand was tied in a single knot under the heel.

The smaller sandal, woven in the same technique, is a bit cruder and might well be the work of an adolescent. On the border, each leaf was brought forward under-two and reintroduced. The toe ends were mostly drawn out on top, intertwined, and left to form a knotty pad. In finishing the heel, one strand was brought squarely across and the others looped about it, half above and half below, after which their ends were clipped. As a final touch, two strips, tied together on the middle left edge, were laced back and forth across the sandal, one to end at the toe; the other at the heel.

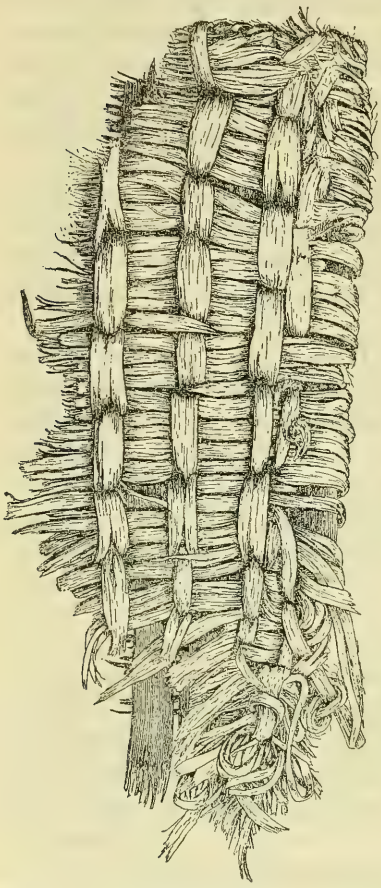


FIGURE 20.—WICKERWORK SANDAL WITH SECONDARY STITCHING

Although our wickerwork sandals (pl. 41, 1–3) present an entirely different appearance, one from the other, the method of their manufacture was much the same. All are made of yucca. Coarse leaves were looped and tied to form four warp strands; back and forth across these, over one and under the next, the weft element was woven. This might be narrow yucca leaves (2, 3) or a sort of bast of finely shredded leaves (1). Apparently to bind these weft strands together, strips of the same material were sometimes laced through longitudinally between the warps, as in 3. The extreme to which such stitching can go is illustrated by Figure 20.

One fragment in the lot is woven of yucca bast over four warp strands of coarse yucca cord.[18]

Basketry.—In our 1917 Betatakin collection, basketry is represented by the two specimens figured in Plate 42 and by several fragments (312394) of similar vessels. The ring basket (1), a very common sort of receptacle among cliff dwellers of the Kayenta district, is woven of trimmed yucca leaves in simple twilled pattern; that is, each weft

[18] For an excellent analysis of wickerwork and twilled technique in sandal weaving, see Kidder–Guernsey, 1919, pp. 101–107.

element alternately goes over-two, then under-two warp elements. Construction began at the center and the two primary strands, at right angles to each other, tend naturally to quarter the fabric. Continuing outward from the middle along these two strands, every fourth weft element extends over-three thus to produce the concentric diamond pattern faintly discernible in the illustration. At the rim, the component strands were gathered in pairs and clipped. Each alternate pair was brought over from the outside and tied with its neighbor just below the ring, by thin twined strips of yucca. In this particular specimen, the unpeeled willow forming the hoop had been broken and subsequently repaired with a similar withe, lashed on with more shreds of that most useful plant, the yucca.

As to our coiled specimen (pl. 42, 2) and fragments, little need be said other than that each was woven in the manner described by Kidder and Guernsey [19] as "two rod and bundle." In this style, each coil consists of two tiny willow rods, placed side by side with a bundle of fibrous material above and between them. Coiling progressed as the sewing splints were drawn through the middle of the bundle and over the three elements (two rods and bundle) of the coil next above.

In the small series of Betatakin artifacts collected by Professor Cummings and obtained by the United States National Museum through exchange with the University of Utah, are two fragmentary yucca ring baskets of twilled weave. (Pl. 43.) One (1) is woven over-three, under-three, with each sixth element on the quartering strands over-five; the other (2), over-two under-two, as described above. The fragment of a larger ring basket, approximately 15 inches (0.381 m.) in diameter (303269), and part of a coiled specimen, 6½ inches (0.165 m.) in diameter, woven on a single-rod and welt foundation (303270), will also be found in this collection.

Cradles.—During the course of our clearing operations we found a fragment of what might have been a cradle (312396). Uncertainty lies in the fact that the specimen, when in use, obviously was broader than known cradles from the Kayenta district; from the further fact that the reed backing follows the curve of the hoop without apparent interruption. This hoop is an unpeeled oak withe; the reeds were added one at a time, each being bent around the oak frame and lashed with a pair of twined yucca strands.

Plates 44 and 45 show the front and back of a fragmentary cradle of superior construction, exhumed at Betatakin by Professor Cummings in 1909. A peeled oak twig, partly split to aid in

[19] 1919, p. 116.

bending it to the shape desired, forms the frame. To the under side of this, selected reeds were bound by a single yucca-leaf strand in running coiled stitch.[20] Such lashing, and a cornhusk pad that covered it and the reed ends, was subsequently inclosed by twilled weaving (over-three, under-three) of unidentified basketry material. The original dimensions of this exceptional specimen were approximately 12 by 24 inches (0.304 by 0.609 m.).

Two sets of reeds, at right angles to each other, compose the body of the cradle. First to be attached was the transverse series above mentioned, of which 72 elements now remain. Upon these, 26 longitudinal rods were bound in pleasing pattern with two-ply cords of human hair. Close inspection of the illustrations will show the running coiled stitch that binds the outermost stems of the upper set to each one in the lower. The lowermost and each twenty-fifth cross reed above (pl. 45) is fastened to individual rods of the opposite series by a wrapped stitch in which a single cord twines about the horizontal member as it crosses, successively, those placed lengthwise. This method of attachment resulted in a sequence of three rectangles each of which is bisected diagonally by coiled stitching.

It is to be noted that only 2-ply human hair cord was utilized as a sewing element in binding the two sets of reeds which compose the body of the fragmentary cradle before us. But a shred of yucca leaf, looped over several lateral stems, served subsequently for minor repair.

Foodstuffs.—Maize has formed the staple food crop of Pueblo peoples since Basket Maker times. Innumerable cobs appeared in the household rubbish with which Betatakin was terraced; those few we salvaged (312266) average 6½ inches (0.165 m.) and are among the longest. We found also three small red beans (*Phaseolus vulgaris*—No. 312268) [21] and various squash stems, seeds, and fragments of rind (*Cucurbita pepo*—Nos. 312261, 3, 5). Pinyon nuts, the seeds of desert grasses, and edible roots, such as a species of wild potato that grows abundantly in canyons of the Kayenta district, contributed, each in its proper season, to the products of cultivated gardens. No useful list of the divers game animals killed for food can be compiled from the handful of worked bones retained.

Figure 21 shows two severed fragments of a gourd vessel. It is understood that to-day, as in prehistoric times, young wild gourds are still eaten by several Southwestern tribes.

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[20] The thread crosses the twig, goes down and encompasses two reeds beneath; thence back over the twig and down again to inclose one of the same two reeds and the next beyond; thence back over the twig, and so on.

[21] This and the following identifications were made by Mr. D. N. Shoemaker, of the Bureau of Plant Industry, U. S. Department of Agriculture.

POTTERY

The half dozen specimens we recovered afford no adequate conception of the variety of earthenware vessels employed in Betatakin nor of the skill that went into their making. From shards gathered on débris heaps, something could be written of local technique; of different wares and their characteristic types of paste, surface treatment and decoration. But this has already been done by those diligent, painstaking observers, Kidder and Guernsey.[22]

Let us briefly consider the few pieces in hand since they are the only ones in the National Museum collections known to have come from Betatakin.[23] Our two whole vessels (pl. 46, 1, 3) are both polychrome. The flat-topped colander (1) was finished with a red slip, except for a narrow, cream-colored band around the shoulder; on this smooth red surface black geometric decorations were painted and outlined in white. Ornamentation is confined to the body and to the slightly depressed rim. The flat bottom is perforated by 41 holes, one-eighth inch in diameter, punched through from the outside. This is the strainer previously noted as having been found in the hole pecked in the stone floor of room 121.

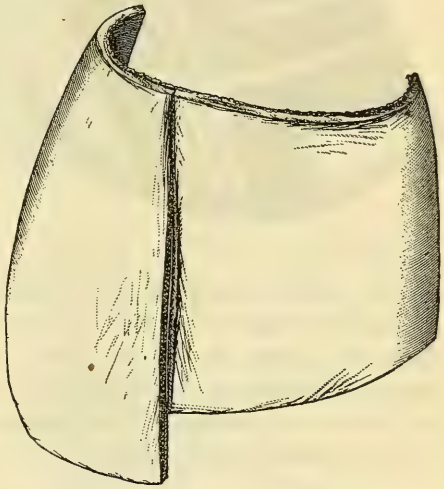

FIGURE 21.—FRAGMENT OF GOURD VESSEL, CUT IN TWO

To the gray paste of the small handled jar (3), a brown paint was applied from the rim to just below the maximum diameter; over this, black designs were drawn and bordered with white. The larger jar (5) likewise was rubbed to a near-polish with waterworn pebbles then ornamented directly with broad, brown bands, outlined with a darker paint that may be regarded as an impure black. The same pigment was employed in tracing the coarse, parallel lines that occupy the interspaces. Bits of wood, gourd rind, and fragments of broken pottery (fig. 22) were employed as scrapers in the manufacture of earthenware vessels.

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[22] See Kidder-Guernsey, 1919, pp. 129–143; Kidder, 1924, pp. 68–74.

[23] Accession 52301, transferred from the Bureau of American Ethnology, includes a number of vessels perhaps erroneously credited to Betatakin by the collector, Dr. J. W. Fewkes. Certainly they display none of the distinguishing features of Kayenta, or even proto-Kayenta, wares. In the report on his preliminary visit, Fewkes implies (1911, p. 26) that fragments only were gathered at this site.

Of the two bowls, both restored, the larger (6) was first coated inside and out with a thin red slip, polished and then decorated with a coarsely hachured, convoluted design in black. Ornamentation is limited to its inner surface. The smaller specimen (2) has an out-flaring rim and a single, horizontally placed loop-handle—two characteristic features of bowls belonging to the principal Kayenta culture. But this particular vessel bears no decoration whatsoever. Its exterior was roughly smoothed; its inner surface was covered with a cream-colored slip and polished. Variation in Betatakin bowl rims is shown by Figure 23, drawn from fragments in our shard collection.

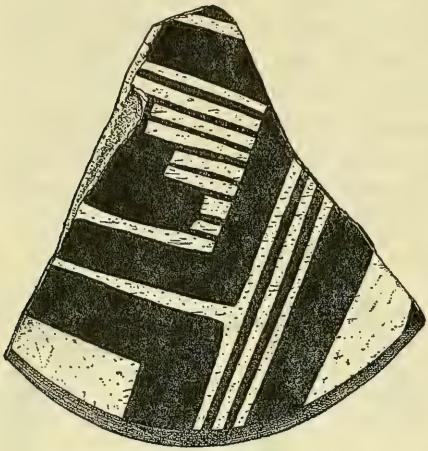

FIGURE 22.—SHARD POTTERY SCRAPER

In this same series are segments of four shallow, platelike vessels with perforated edges (fig. 24), a type limited in distribution, s far as I am aware, to the Kayenta district, and to Jadito Valley, southeast of the modern Hopi villages. Fewkes [24] illustrates a restored specimen, 5¼ inches (0.133 m.) in diameter, from the Marsh Pass region; Kidder and Guernsey [25] observed fragments of similar dishes on ruins in the same locality and were so fortunate as to recover half of a 13-inch (0.330 m.) plate, threaded with strips of yucca, at Sunflower House, on the

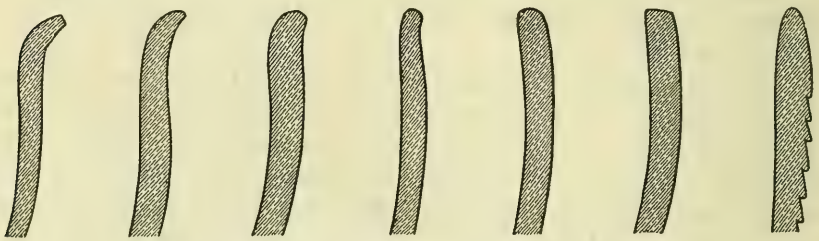

FIGURE 23.—RIM TYPES OF BETATAKIN BOWLS

south margin of Skeleton Mesa some 2 miles below the mouth of Segi Canyon. Both their pronounced shallowness and their marginal perforations attract attention to these unusual vessels. What purpose they originally served remains undetermined. Hough appears to be the only one who has ventured an opinion. After noting the occurrence of fragments in large numbers at Kawaiokuh and

[24] 1911, pl. 15, *b*.

[25] 1919, p. 143.

their relative infrequence at Kokopnyama, protohistoric Hopi villages in Jadito Valley, he conjectures the use of such plates as "revolving rests for ware during the process of manufacture." [26]

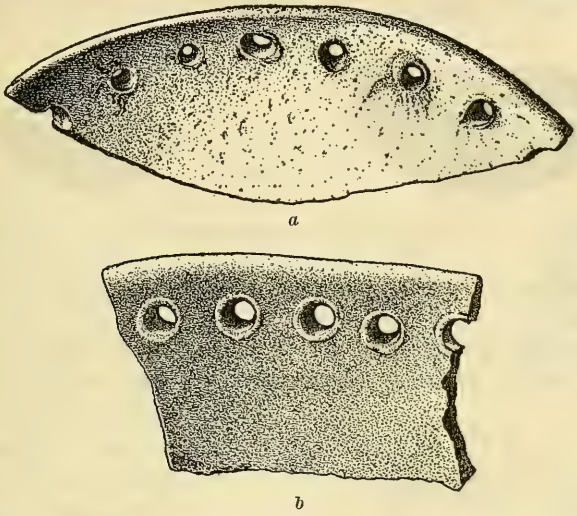

FIGURE 24.—RIM FRAGMENTS OF POTTERY PLATES

In other words, a rotative disk that could be turned as the formative vessel it supported took shape—nearest aboriginal approach in the New World to the potter's wheel.

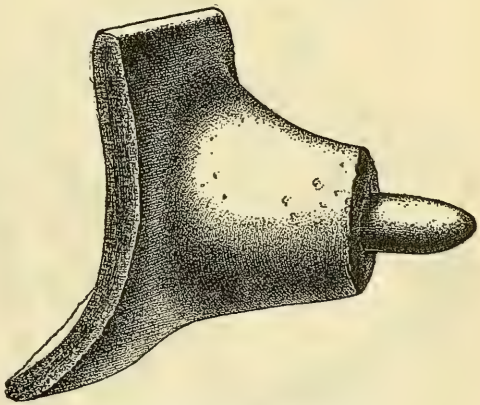

FIGURE 25.—LADLE FRAGMENT

Like the two jars previously mentioned, the broken ladle shown in Plate 46, 4 received no surface slip. It bears no trace of ornamentation either within the bowl or on its flat, solid handle. In prehistoric times, as to-day, Pueblo potters habitually modeled a ladle handle separately and frequently attached it by inserting one end through a hole punched in the still plastic clay of the bowl, the union then being smoothed over and completely obliterated. This union, in the case of tubular handles, was occasionally strengthened by a cylindrical clay plug, molded separately and introduced from the bowl after the handle was joined to its exterior. (Fig. 25.)

[26] See Walter Hough: Archæological Field Work in Northeastern Arizona. The Museum-Gates Expedition of 1901. U. S. National Museum, 1901, An. Rept., pp. 337 and 343. Washington, 1903.

Miniature vessels (fig. 26).—These two tiny specimens are perhaps to be regarded as toys for small girls. The larger was crudely modeled and sundried; the smaller, on the other hand, is quite regular in shape and fired. On its inner surface are striations left

a *b*

FIGURE 26.—MINIATURE VESSELS

by the scraping tool. Part of a third miniature vessel (312254) is also present.

Effigy fragment.—Kidder and Guernsey [27] found two small effigies on the surface at Ruin A, Marsh Pass. Our Betatakin fragment (312306) is the head from a very similar, though less realistic, specimen. The face is flat—a bit of gray clay pressed between thumb and index finger. The nose is not indicated; eyes and mouth are represented merely by pricks made with a bone awl or like instrument. From this head the neck and rectangular body, if any, have been broken. It should be noted that the specimen is unfired.

FIGURE 27.—LEATHER BAG FRAGMENT

Clay pellet (312314).—A flattish ball of molded red clay, 1⅜ inches (0.034 m.) in diameter by ⅞ inch (0.022 m.) thick, is in the collection. With like balls, no doubt, village boys improved their marksmanship, for daubs of variate clay still adhere to the higher walls of Betatakin cave, clustered about casual targets.

[27] 1919, p. 143.

LEATHER OBJECTS

Animals slain on the chase furnished flesh for hungry aborigines, bones from which their needed tools could be fashioned, hides suitable for clothing and other purposes. Implements of bone from Betatakin have already been listed; we are now briefly to consider the only two scraps of leather in our 1917 collection.

Figure 27 is part of a bag, made by sewing together with sinew two round-bottomed pieces of tanned hide. In their present condition these resist absolute identification. They closely resemble buckskin and yet are too thin. Perhaps mountain sheep hide was utilized. Whether or no, the bag when in use was approximately 2½ inches (0.063 m.) in diameter. Rodents have gnawed away the upper portion.

Figure 28 represents a trimmed bit of buckskin so well tanned that even today it is as soft and pliable as a piece of chamois. It was perforated at each end for sewing; a fragment of cotton cord occupies a hole on one margin. Traces of white paint adhere to both sides.

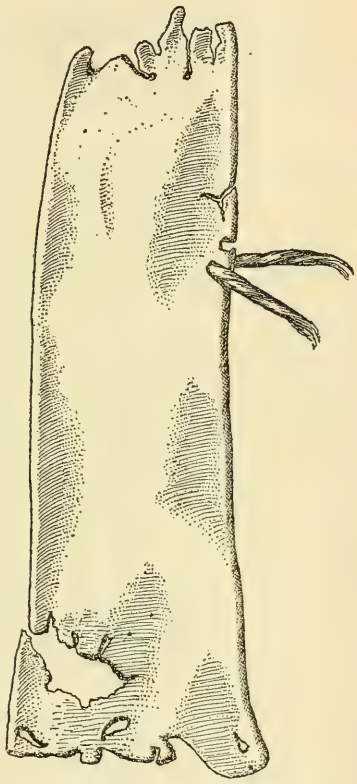

FIGURE 28.—PAINTED BUCKSKIN

In these concluding paragraphs the reader is again reminded that this abridged description is not intended to convey more than a summary of the work of excavation and repair undertaken in the early spring of 1917. Other students of southwestern archeology have found need for certain architectural notes at our command and have urged their publicaiton. But it is to be emphasized that our observations pertain only to the shell of Betatakin; not to the kernel within. Even though the privilege were properly ours we lack the essential data from which to write the story of this fascinating ruin.

The place of Betatakin in Pueblo history is well known. It was one of the last occupied cliff dwellings; its former inhabitants moved southwardly in late prehistoric times to unite with other clans, and these, in turn, migrated under pressure of nomadic tribes shortly before advent of the Spaniards in 1540. But Fewkes has drawn too short a trail from Betatakin to the modern Hopi villages; has accepted too literally, I am sure, the traditions of his Hopi friends. Future exploration and painstaking attention to details should shortly identify those sites at which the Betatakin folk successively lingered after they abandoned Segi Canyon.

APPENDIX I

TABLE OF ROOM DIMENSIONS[28]

Room	North or northeast		East or southeast		South or Southwest		West or northwest		Floor to beams	
	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters
	′ ″		′ ″		′ ″		′ ″		′ ″	
1	5 3	1.60	6 0	1.82	1 7	0.48	7 2	2.18	4 11	1.49
2	4 11	1.49	5 1	1.54	5 5	1.65	5 5	1.65	4 8	1.42
					5 6 SW	1.67				
3	6 11	2.10	9 8	2.94	4 9 T.	1.44	10 6	3.20	4 3	1.29
					5 4 B.	1.62				
4					6 0 *e.*	1.82	6 4	1.93		
5	4 4	1.32	7 4	2.23	4 0	1.21	9 6	2.89	5 3	1.60
6	3 9	1.14	7 6	2.28	4 1	1.24	9 3	2.82	4 4	1.32
7	5 11	1.80	8 0 *e.*	2.43	5 7	1.70	8 9	2.66	4 6	1.37
8										
9			7 0 *e.*	2.13	4 0 *e.*	1.21				
10	Ct. 8 0 *e.*	2.43								
11	8 7	2.61	11 1	3.37	8 3	2.51	11 0	3.35	4 5	1.34
12	4 11	1.49	4 0	1.21	4 6	1.37	3 11	1.16	4 2	1.27
13	Ct. 9 4	2.84	16 0	4.87	10 6 *e.*	3.20	9 2	2.79		
14	7 9	2.36	8 5	2.56	9 1	2.76	9 5	2.87	4 7	1.39
15	9 5	2.87	6 0 *e.*	1.82	9 6	2.89	6 8	2.03	6 1	1.85
16	11 0 *e.*	3.35	5 8	1.72	10 9	3.27	5 10	1.77	5 1	1.54
17	9 9 T.	2.97	4 0	1.21	9 8 T.	2.94	4 6	1.37	4 9	1.44
	7 9 B.	2.36			8 3 B.	2.51				
18	9 5	2.87	10 4	3.15	8 5	2.56	10 6	3.20	4 8	1.42
19	Ct. 8 1	2.46	16 7	5.05						
20	7 10	2.38	8 9	2.66	6 9	2.05	9 2	2.79	6 4	1.93
21	6 7	2.00	16 10	5.13	6 7	2.00	16 8	5.08	4 11	1.49
22	5 4	1.62	9 3	2.82	7 3	2.21	10 1	3.07	5 7	1.70
23	4 6 *e.*	1.37	5 5	1.65	6 2	1.88	6 2	1.88		
24	Ct. 14 7	4.44	8 7	2.61	11 6 *e.*	3.50	9 0	2.74		
25	9 3	2.82	8 8	2.64	9 5	2.87	8 10	2.69	4 5	1.34
26	4 10 T.	1.47	8 0	2.43	4 5 T.	1.34	7 6	2.28	4 7	1.39
	1 8 B.	0.50			1 3 B.	3.81				
27	8 1	2.46	8 1	2.46	8 3	2.51	8 5	2.56	4 2 *e*	1.27
28	Ct. 5 3	1.60					6 0 *e.*	1.82		
29	8 1	2.46	7 11	2.41	9 3	2.82	8 1	2.46	4 11	1.49
30										
31	5 4	1.62	8 0	2.43	4 11	1.49	8 4	2.54	4 3	1.29
32	5 1	1.54	8 0	2.43	4 10	1.47	8 0	2.43		
33	4 2	1.27	6 8	2.03	3 2	0.96	7 2	2.18	3 4	1.01
34	Ct.		15 0 *e.*	4.57	5 0 *e.*	1.52	16 0	4.87		
35	10 7	3.22	10 3	3.12	10 0	3.04	8 1	2.46	4 6	1.37
37	Ct. 11 5	3.48	11 3	3.42	9 11	3.02	12 5 T.	3.78		
							9 2 B.	2.79		
39	7 0 *e.*	2.13	9 2 *e.*	2.79	6 3	1.90	8 8	2.64		
40			21 0 *e.*	6.40	1 6	0.45				
41	6 11	2.10	11 0	3.35	6 11	2.10	12 0	3.65	6 0	1.82
42										
43	7 2	2.18	6 6	1.98	6 5	1.95	5 8	1.72	4 4	1.32
44	7 7 T.	2.31	6 8	2.03	5 3 T.	1.60	9 10	2.99		
	3 2 B.	.96			1 5 B.	0.43				

[28] With such irregularities of masonry as occur in Betatakin and with such a pronounced slope as that on which the village was constructed it follows that these room measurements are more or less arbitrary. No two observers will get identical results unless, by chance, their respective tapes are stretched between the same identical building stones. In the present instance the measurements given were taken as near the floor as possible, with these exceptions: "T" denotes one made at the top of the wall; "B," one made at its base; "*e*" identifies an estimated dimension. Ceiling heights were taken between the floor and the principal beams, usually 4 to 6 inches in diameter; not to the lesser poles supported by those beams.

The writer confesses with sincere regret that some of his room measurements were rendered illegible when the notebook recording them was thoroughly soaked during the snowstorm of May 31—a loss discovered too late for correction.

Table of room dimensions—Continued

Room	North or northeast		East or southeast		South or Southwest		West or northwest		Floor to beams	
	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters
	′ ″		′ ″		′ ″		′ ″		′ ″	
45	Ct. 16 10	5.13	13 2	4.01	10 0 *e.*	3.04	12 3	3.73		
46	9 0	2.74	8 4	2.54	10 3	3.12	10 8	3.25		
47					8 0 *e.*	2.43				
48	4 0 T.	1.21	2 8	.81						
	1 4 B.	.40								
49			14 0 *e.*	4.23	4 9	1.44	15 0 *e.*	4.57		
50			10 0 *e.*	3.04	6 9	2.05	12 0 *e.*	3.65		
51	5 4	1.62	7 10	2.38	4 11	1.49	8 3	2.51		
52			8 11	2.71	4 7	1.39	7 7	2.31		
53	5 0 *e.*	1.52					8 7	2.61		
55	12 8	3.86	7 6 *e.*	2.28			8 4 *e.*	2.54	8 0 *e.*	2.43
56	10 10 T.	3.30	5 8	1.72	8 6 T.	2.59	5 3 T.	1.60		
	5 11 B.	1.80			4 0 B.	1.21	4 5 B.	1.34		
57	9 10 T.	2.99	7 2	2.18	7 2 T.	2.18	6 5	1.95		
	5 3 B.	1.60			3 5 B.	1.04				
58	4 0	1.21	4 6	1.37	2 11	.88	4 8	1.42		
59	4 10	1.47	7 6	2.28	3 10	1.99	8 2	2.48	4 3	1.29
60	10 3 T.	3.12	7 5	2.26			7 6	2.28		
	4 11 B.	1.49			4 9 B.	1.44				
61										
63	4 0 *e.*	1.21	4 4	1.32	3 6 *e.*	1.06	6 4 T.	1.93		
							4 10 B.	1.47		
64			6 9 *e.*	2.05	6 0 B.	1.82				
65										
66	8 0 *e.*	2.43	7 0 *e.*	2.13					3 10	1.99
67	5 0 *e.*	1.52	7 0 *e.*	2.13						
68	8 6 *e.*	2.59	6 0 *e.*	1.82			7 0 *e.*	2.13		
70	7 10 *e.*	2.38	8 4 *e.*	2.54						
71										
73	4 5	1.34	5 2	1.57	5 0	1.52	3 7	1.09		
74										
75	10 0 *e.*	3.04	8 0 *e.*	2.43						
76	8 0 *e.*	2.43								
77	8 0 *e.*	2.43	3 0 *e.*	.91						
78	7 10	2.38	6 4	1.93	6 11	2.10	6 8	2.03	3 8	1.11
79	7 6	2.28	7 0	2.13	7 3	2.21	6 0	1.82	4 9	1.44
80	6 0	1.82	5 10	1.77	6 8	2.03	6 8	2.03		
81	7 7	2.31	5 0	1.52	6 3	1.90	5 10	1.77		
82	8 0 *e.*	2.43	8 0 *e.*	2.43	8 6 *e.*	2.59	7 6 *e.*	2.28		
83	Ct. 12 0 *e.*	3.65	6 0 *e.*	1.82	6 0 *e.*	1.82	10 0 *e.*	3.04		
84	6 0 *e.*	1.82	6 0 *e.*	1.82	5 0 *e.*	1.52	5 0 *e.*	1.52	4 0 *e.*	1.21
85	7 0 *e.*	2.13	5 0 *e.*	1.52	7 0 *e.*	2.13	7 0 *e.*	2.13	4 0 *e.*	1.21
86										
87	7 6 *e.*	2.28	5 6 *e.*	1.67						
88	5 0 *e.*	1.52					6 6 *e.*	1.98		
89	5 0 *e.*	1.52			6 6 *e.*	1.98	6 0 *e.*	1.82		
90	2 0 *e.*	.60			5 0 *e.*	1.52	9 6 *e.*	2.89		
91	4 0 *e.*	1.21			5 0 *e.*	1.52	9 0 *e.*	2.74		
92	3 0 *e.*	.91	5 6 *e.*	1.67	5 0 *e.*	1.52			6 0 *e.*	1.82
93	5 6 *e.*	1.67	7 0 *e.*	2.13	6 0 *e.*	1.82				
94										
95	8 0 *e.*	2.43	9 6 *e.*	2.89	9 0 *e.*	2.74				
96										
100	4 8 T.	1.42	6 1	1.85	4 5	1.34	5 10	1.77	3 0	.91
	2 10 B.	.86								
101			5 0	1.52						
102			6 0 *e.*	1.82						
103										
104										
105										
106										
107							8 0 *e.*	2.43		
108										
109										
110										
111										
112										
113										
114										
115										
116	7 4	2.23								
117	11 5	3.48	6 3	1.90	11 2	3.40	7 4	2.23		
118	7 0	2.13					8 0 T.	2.43		
							5 5 B.	1.65		
119	7 5	2.26	8 0 T.	2.43	7 7	2.31				
			6 3 B.	1.90						

Table of room dimensions—Continued

Room	North or northeast		East or southeast		South or southwest		West or northwest		Floor to beams	
	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters
	′ ″		′ ″		′ ″		′ ″		′ ″	
120	7 9	2.36					8 0 *e.*	2.43		
121	11 0 *e.*	3.35	8 6 *e.*	2.59						
122	8 7	2.61	8 5	2.56	8 5	2.56	9 6	2.89		
123										
124										
125	6 5	1.95	7 10	2.38						
126	8 3	2.51	8 3 T.	2.51	7 3	2.21				
			6 2 B.	1.88						
127							7 0 *e.*	2.13		
128										
129	7 0 *e.*	2.13	7 0 *e.*	2.13						
130										
131										
132										
133										
134										
135										

APPENDIX II

CATALOGUE NUMBERS AND DIMENSIONS OF OBJECTS ILLUSTRATED

Illustration	National Museum No.	Length		Width		Thickness		Diameter	
		Inches	Centimeters	Inches	Centimeters	Inches	Centimeters	Inches	Centimeters
Pl. 31, 1	312206	17	43.1	12	30.4	1½	3.8		
2	312216	11	27.9	4¾	12.0	1	2.5		
3	312227	5¾	14.6	3½	8.8	1	2.5		
4	312227	5	12.7	4¼	10.7	1¼	3.1		
5	312208	11	27.9	5	12.7	2	5.0		
Pl. 32, 1	312238	4¼	10.7	2¼	5.7	1⅝	4.1		
2	312235	6¼	15.8	3¼	8.2	2½	6.3		
3	312237	4¼	10.7	2¾	6.9	2	5.0		
4	312239	5¼	13.3	4	10.1	2½	6.3		
5	312242	3¼	8.2	1¾	4.4	1½	3.8		
6	312233	4	10.1	2¾	6.9	1¾	4.4		
7	312229	3¾	9.5	3	7.6	1½	3.8		
8	312230	5¼	13.3	4	10.1	1½	3.8		
9	312228	4¾	12.0	2¾	6.9	1½	3.8		
Fig. 5	303257	6¼	15.8	1⅛	2.8	½	1.2		
6	312317	2¼	5.7	1	2.5	⅞	2.2		
7	312305					½	1.2	1⅞	4.7
Pl. 33, 1	312345	19½	49.5	6¾	17.1	⅞	2.2		
2	312341	12	30.4	3½	8.8	1⅜	3.4		
3	312342	15¼	38.7	2¾	6.9	1¾	4.4		
4	312340	12	30.4	4¼	10.7	2	5.0		
Pl. 34, 1	312325	37	93.9					⅞	2.2
2	312326	44¾	113.6					⅞	2.2
3	312324	32	81.2					¾	1.9
4	312323	25	63.5	2	5.0	1¼	3.1		
5	312323	22⅜	57.0	1½	3.8	⅞	2.2		
6	312323	23⅝	59.7	1⅜	3.4	1	2.5		
7	312323	22½	57.1	1½	3.8	1	2.5		
8	312405							7	17.7
9	312405							6	15.2
Fig. 8	312324	32	81.2					¾	1.9
9	312303	2¾	6.9	¾	1.9	½	1.2		
10	312413	8	20.3					5/16	.7
11, *a*	312372	2⅜	6.0					⅛	.3
11, *b*	312372	2	5.0					⅛	.3
Pl. 35, 1	312383	7¼	18.4					1½	3.8
2	312332	10½	26.6	5/16	.7	3/16	.4		
3	312347	12	30.4					1½	3.8
4	312339	14¾	37.4					½	1.2
5	312333	13¾	34.9					½	1.2
6	312351	6½	16.5	1¼	3.1	¼	.6		
7	312352	5¼	13.3	1	2.5	3/16	.4		
8	312330	5	12.7	⅝	1.5	9/16	1.4		
9	312334	1¾	4.4					⅝	1.5
Pl. 36, 1	312349	19	48.2					3/16	.4
2	312364	17¼	43.8					⅛	.3
3	312361	18¾	47.6					¼	.6
4	312362	13⅝	34.6					¼	.6
5	312370	9⅛	23.1	3/8	.9	¼	.6		
6	312370	7⅞	20.0	3/8	.9	¼	.6		
7	312370	8½	21.5	5/16	.7	3/16	.4		
8	312370	6¾	17.1	3/8	.9	¼	.6		
9	312370	8⅜	21.2					⅜	.9
10	312370	8	20.3	7/16	1.1	¼	.6		
11	312370	8¾	22.2	7/16	1.1	¼	.6		
12	312283					⅝	1.5	1¾	4.4
13	312286					9/16	1.4	2	5.0
14	312284					¾	1.9	1¾	4.4
15	312288	1⅞	4.7	1⅝	4.1	⅛	.3		
16	312290					¼	.6	1⅜	3.4
17	312289	1¼	3.1	1	2.5	⅝	1.5		

Catalogue numbers and dimensions of objects illustrated—Continued

Illustration	National Museum No.	Length		Width		Thickness		Diameter	
		Inches	Centimeters	Inches	Centimeters	Inches	Centimeters	Inches	Centimeters
Pl. 37, 1	312357	3½	8.8	1⅛	2.8	3/16	0.4		
2	312356	3¾	9.5	⅞	2.2	3/16	.4		
3	312355	6⅜	16.1	⅜	.9	⅛	.3		
4	312359	3	7.6	⅞	2.2	¼	.6		
5	312358	3¾	9.5	⅝	1.5	5/16	.7		
6	312389	6½	16.5						
7	312386	6¼	15.8						
8	312387	5¾	14.6						
9	312388	7½	19.0						
Fig. 12, *a*	312353	5¼	13.3	1	2.5	¼	.6		
b	312354	5¼	13.3	⅝	1.5	3/16	.4		
13	312348	10⅜	26.3	1	2.5	¼	.6		
14	312347	12	30.4					1½	3.8
15, *a*	312337	6	15.2	1⅜	3.4	⅜	.9		
b	312337	3⅛	7.9	1⅛	2.8	3/16	.4		
16	312297	⅞	2.2					1⅛	2.8
17, *a*	312350	6	15.2						
b	312349	19	48.2					3/16	.4
18	312406	7½	19.0						
Pl. 38, 1	312374	4¼	10.7	⅝	1.5				
2	312374	6⅛	15.5	9/16	1.4				
3	312374	2 13/16	7.1						
4	312374	5	12.7	9/16	1.4				
5	312374	3 7/16	8.7	3/16	.4				
6	312374	4 1 1/16	11.9	5/16	.7				
7	312375	5	12.7					¼	.6
8	312375	6 5/16	16.0					¼	.6
9	312379	4¼	10.7	1⅜	3.4				
10	312378	6⅜	16.1	1½	3.8				
11	312380	3⅛	7.9	⅞	2.2				
Fig. 19	312376	2⅝	6.6	¼	.6				
Pl. 39, 1	312318	4½	11.4						
2	312319	8	20.3						
3	312320	4½	11.4						
4	312273	2	5.0						
5	312390	2¼	5.7						
6	312259	7	17.7						
7	312259	10	25.4						
8	312259	10	25.4	2	5.0				
9	312259	9	22.8	3½	8.8				
Pl. 40, 1	312407	11	27.9	4¼	10.7				
2	(1)								
3	312407	7¼	18.4	3	7.6				
Pl. 41, 1	312407	11	27.9	4¾	12.0				
2	312407	8	20.3	2½	6.3				
3	312407	9¾	24.7	4	10.1				
Fig. 20	312407	8¾	22.2	3½	8.8				
Pl. 42, 1	312392							9½	24.1
2	312393							11	27.9
Pl. 43, 1	303268							11½	29.2
2	303271							11	27.9
Pl. 44	303275	22	55.8	11	27.9				
45	(1)								
Fig. 21	312262	5	12.7					5¼	13.3
Pl. 46, 1	312244					2¾	6.9	5	12.7
2	312248					2½	6.3	5½	13.9
3	312245					2½	6.3	2½	6.3
4	312249	3½	8.8					2½	6.3
5	312246					4	10.1	5¼	13.3
6	312247					4½	11.4	7¼	18.4
Fig. 22	312256	2¼	5.7	2⅛	5.3	⅛	.3		
Fig. 23	312255								
Fig. 24, *a*	312255	2½	6.3	1½	3.8	¼	.6		
b	312255	4	10.1	1½	3.8	¼	.6		
Fig. 25	312255								
Fig. 26, *a*	312252					⅝	1.5	1¼	3.1
b	312253					⅜	.9	1	2.5
Fig. 27	312270	5½	13.9	4	10.1				
Fig. 28	312271	3¾	9.5	1	2.5				

[1] Same specimen.

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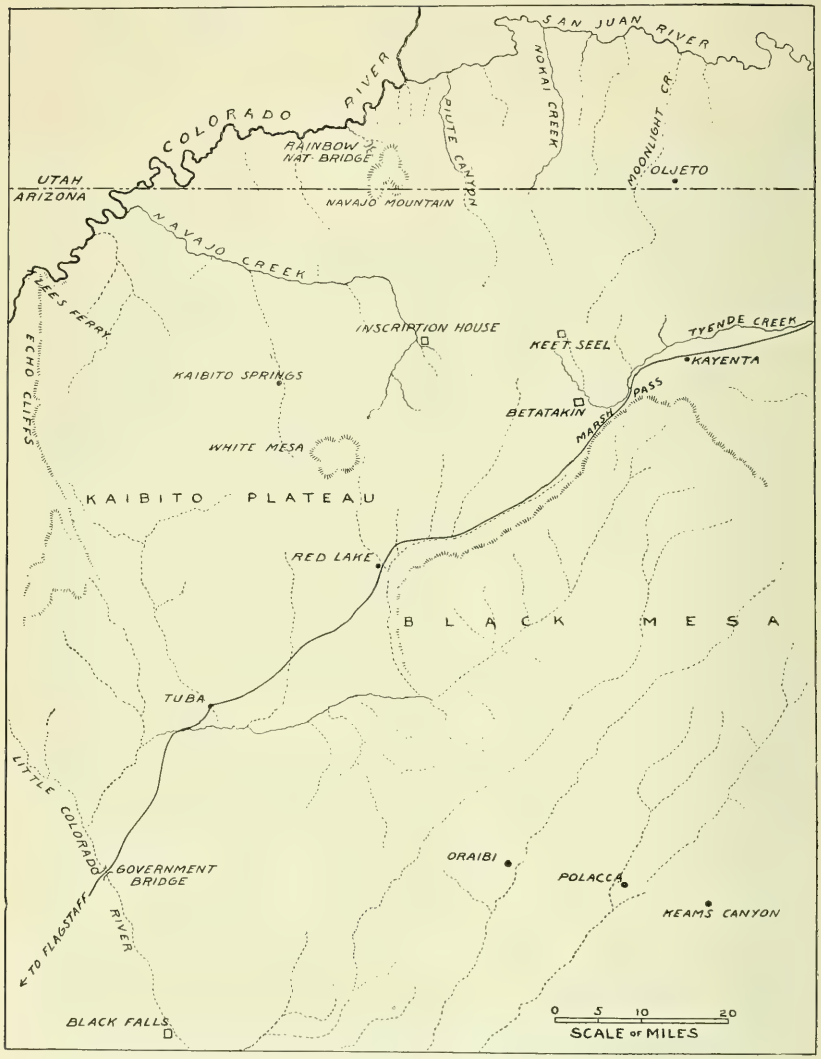
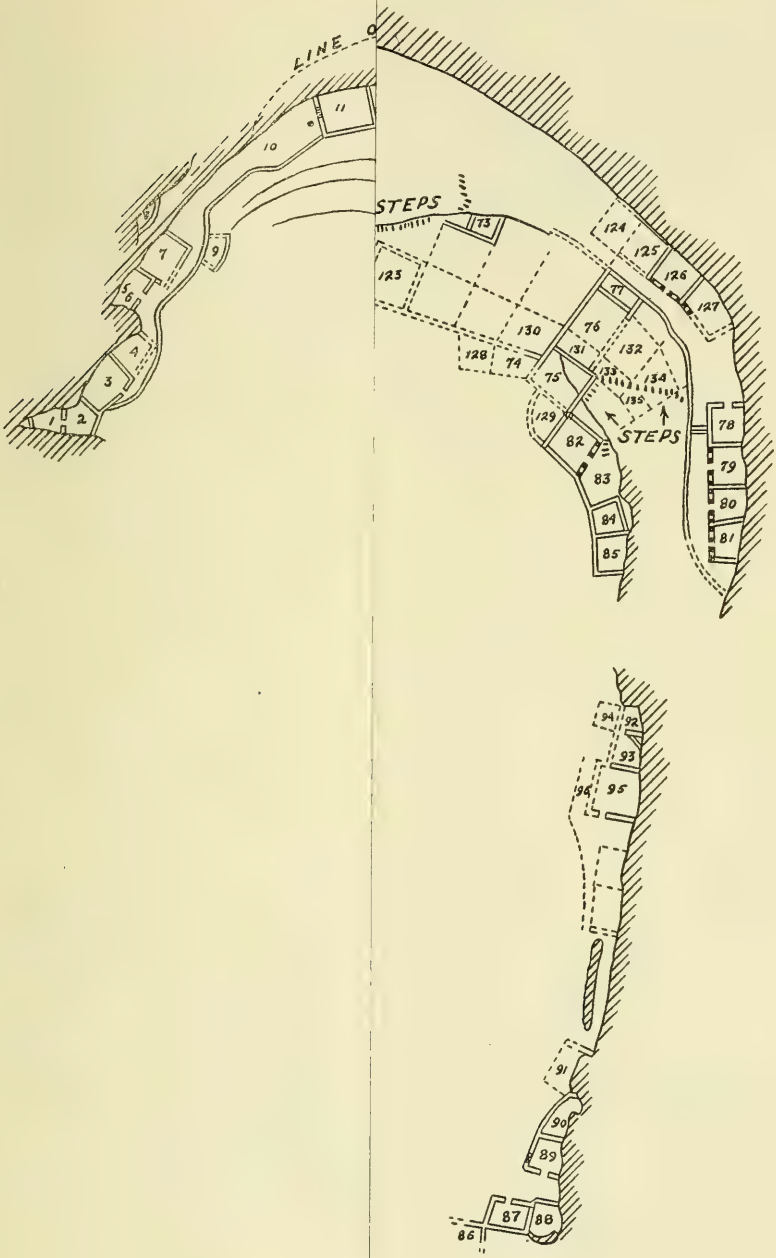
BETATAKIN BLENDS NATURALLY WITH THE WALLS OF ITS VAST CAVE. (1926 PHOTOGRAPH, BY COURTESY OF DR. A. E. DOUGLASS)



MAP SHOWING THE THREE UNITS OF NAVAJO NATIONAL MONUMENT


LINE
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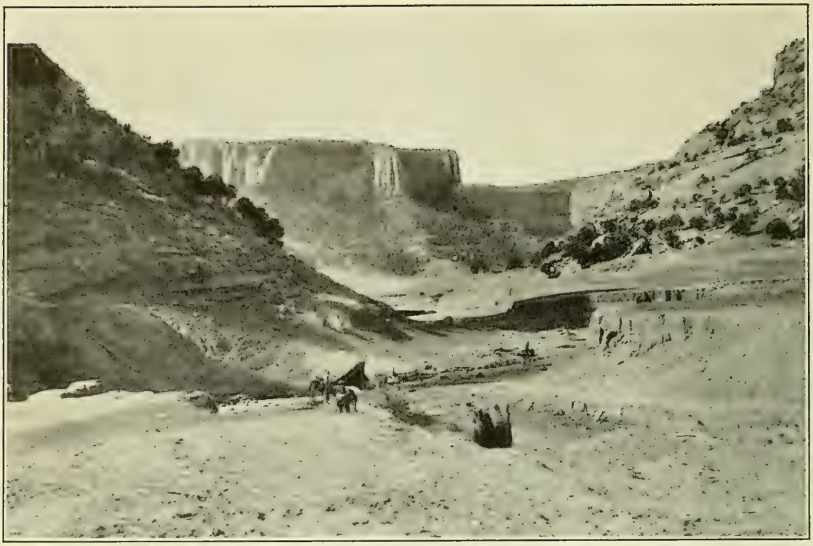
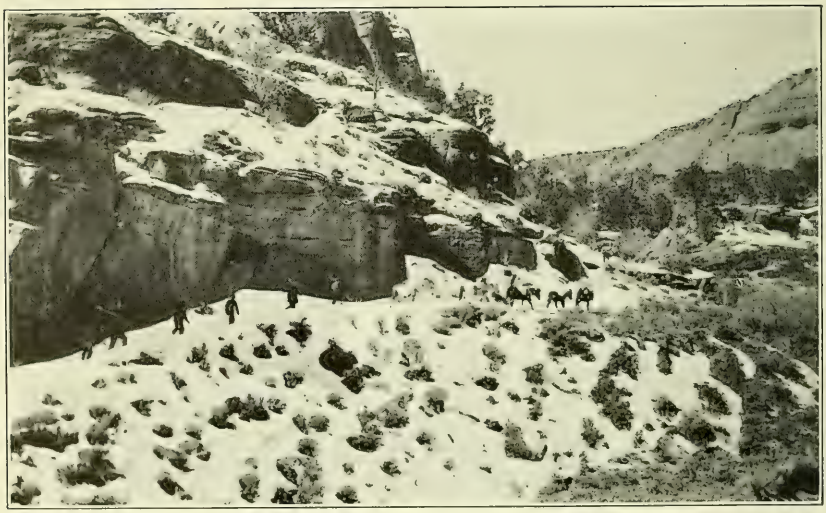
GROUND PLAN OF BETATAKIN RUIN

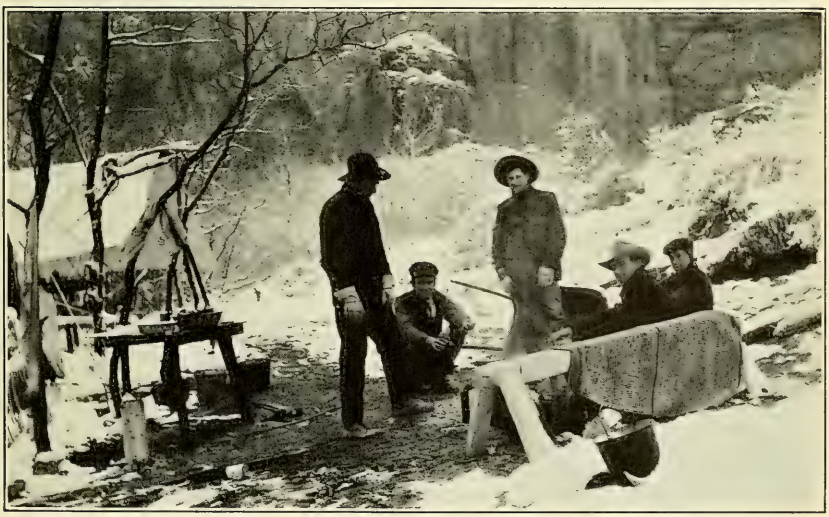


A. TRAIL SCENE IN SEGI CANYON IN AUGUST, 1908



B. APPROACHING BETATAKIN RUIN ON MARCH 27, 1917

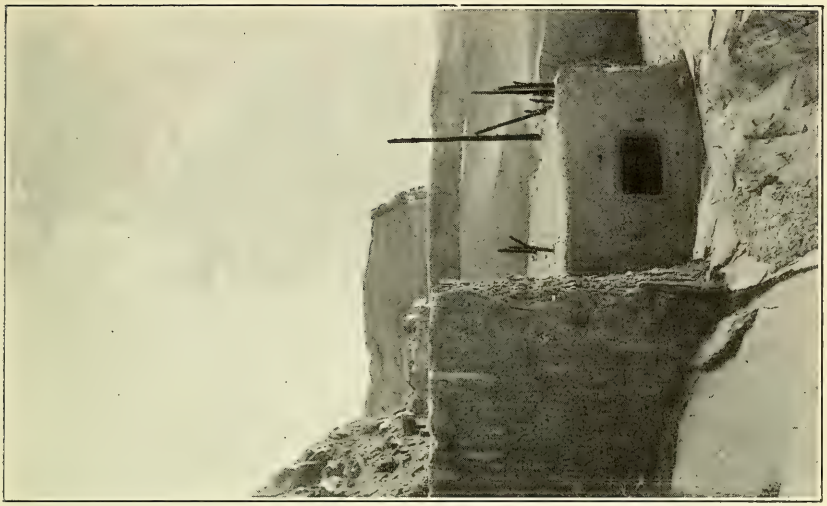
A. BLANKETED WITH SNOW, CAMP WAS A DISMAL PLACE



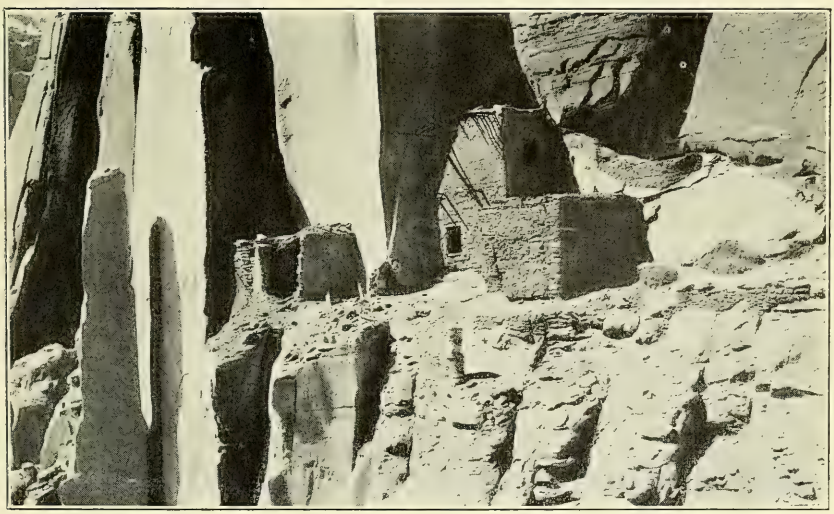
B. WAITING FOR WHATEVER THE COOK MIGHT PROVIDE

A. The Principal House Group Before Excavation, as Viewed from Room 75. Room 66 Stands at the Lower Right

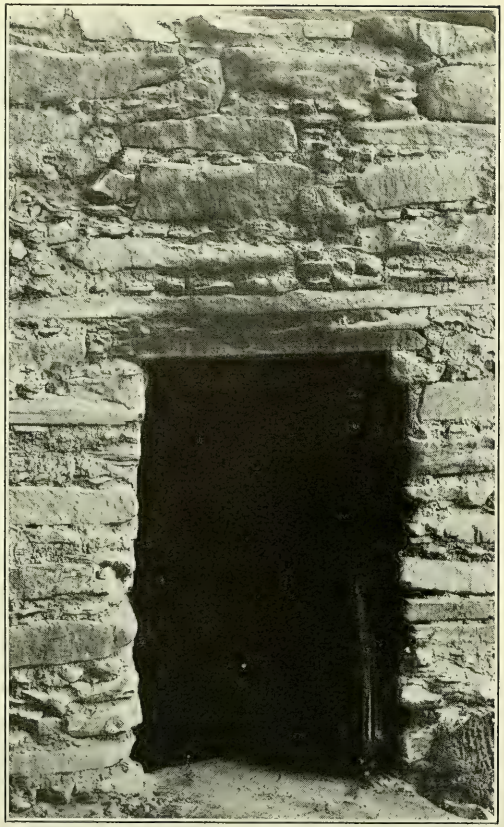
B. Above Rooms 66 and 117, in the Right Foreground, One Notes the Seepage Zone Which Formerly Watered Diverse Vegetation



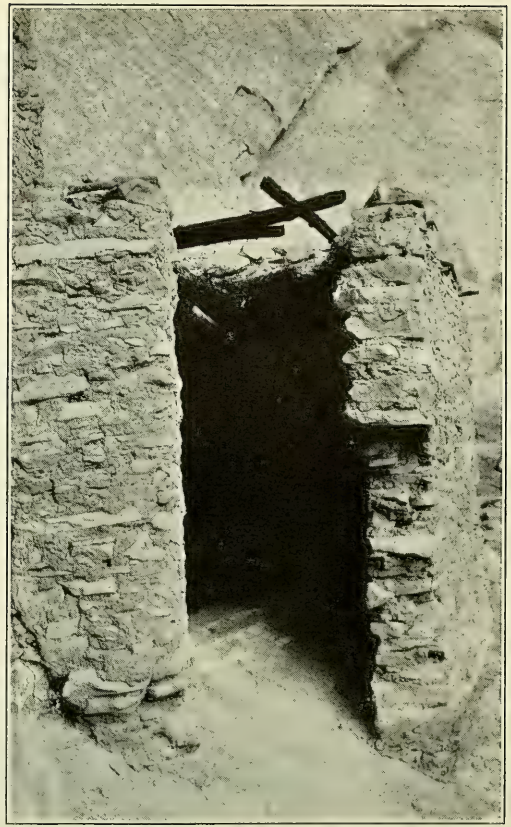
A. THE DOOR OF ROOM 6 AND, ON THE RIGHT MARGIN, THE CONVEX FOUNDATION OF ROOM 8



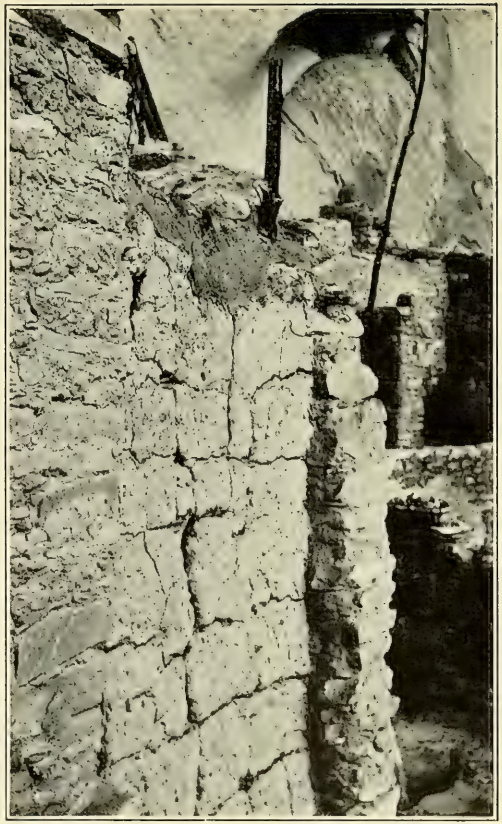
B. ROOMS 3–7 AND THE NEAR-BY RETAINING WALL, AS VIEWED FROM THE ROOF OF ROOM 20



A. A Small Pole Formed a Secondary Jamb for the Door to Room 18

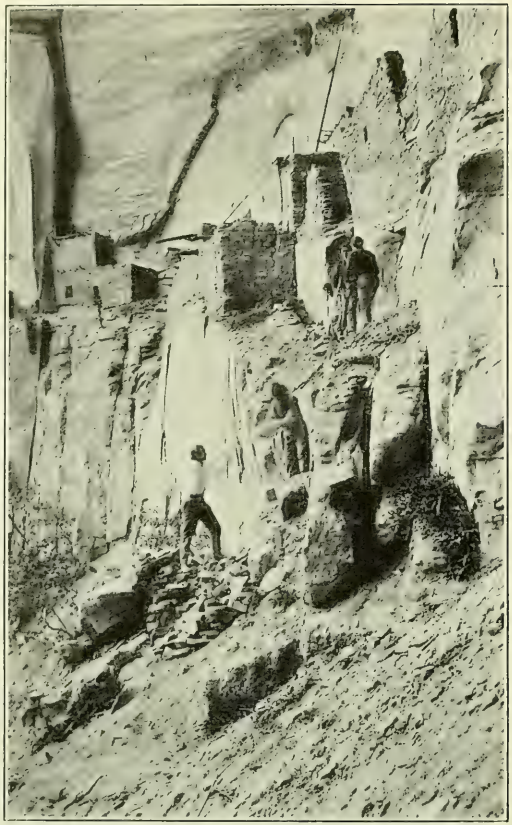


B. The Problematical, Unusual Door in the Southeast Corner of Room 7



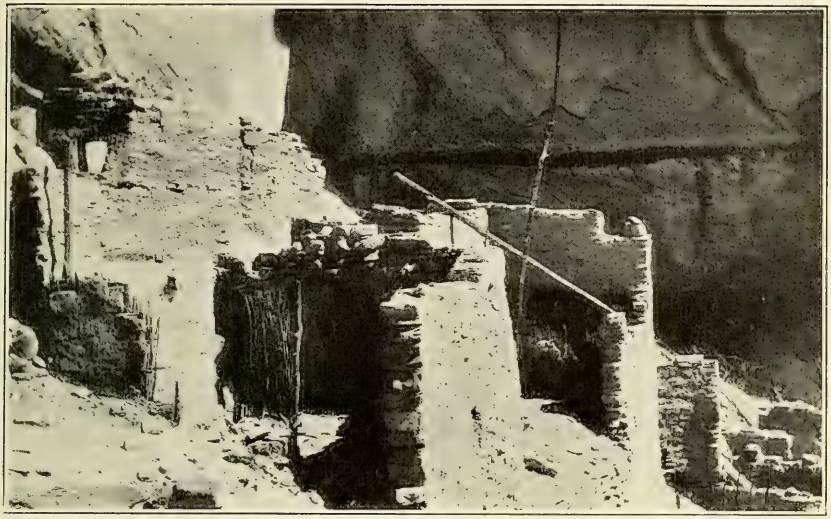
A. Room 17 Boasts the Best Preserved Wattled Wall in Betatakin. At Its Top Is a Fresh Patch of Adobe Mud

B. Here Is Shown the Partly Blocked First-story Door of Room 66 and the Shadowed Fireplace in Room 121

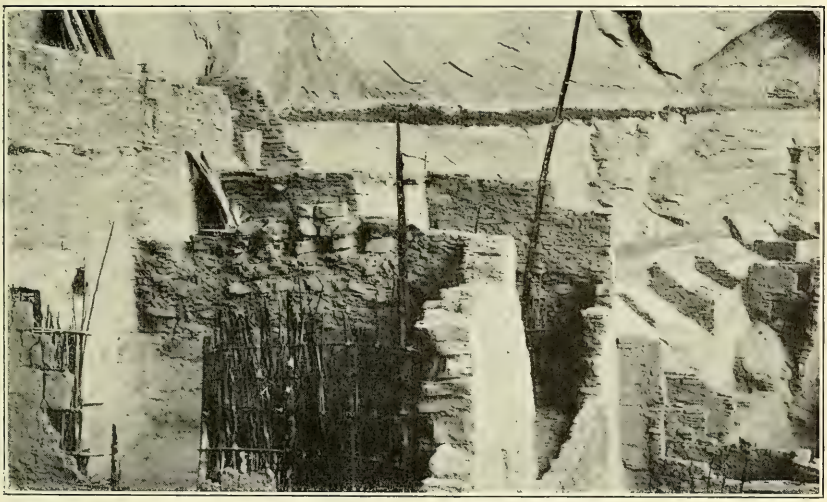


A. BUILDING STONES WERE SALVAGED FROM THE TALUS SLOPE AND PASSED UP FOR USE IN WALL REPAIRS

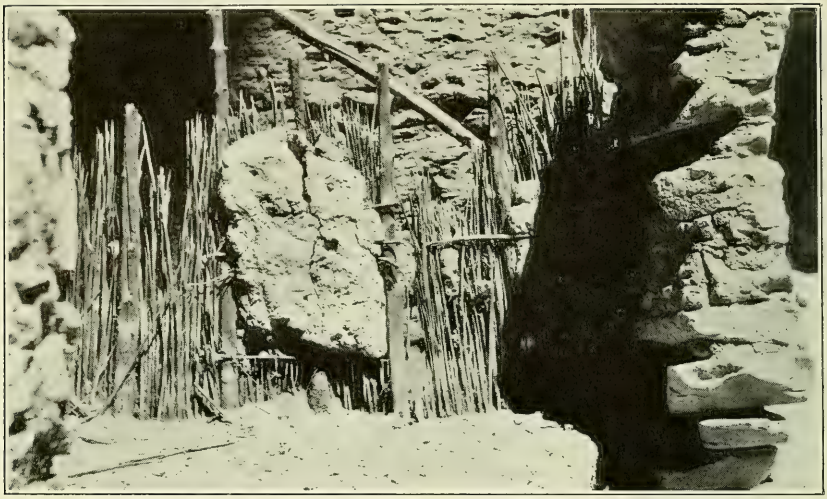
B. ROOM 20, FROM THE SOUTHWEST, SHOWING, ABOVE THE WORKMAN, A STEEL PLATE AND ANCHOR ROD



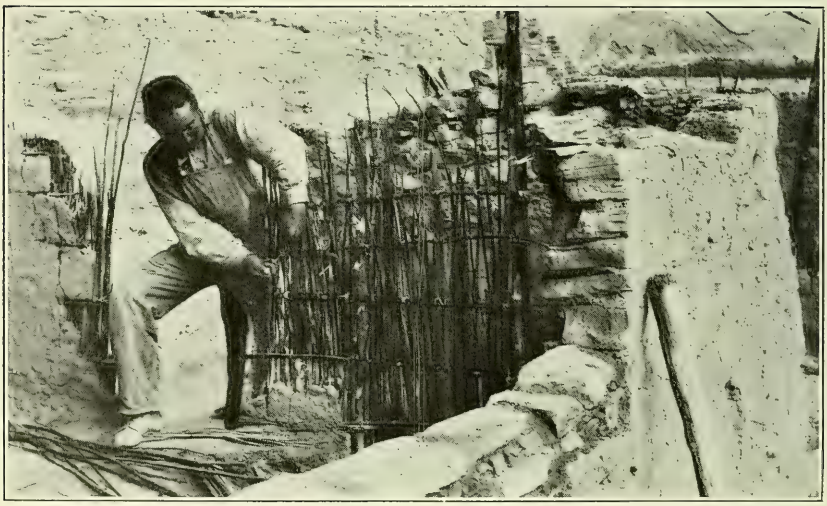
A. The Northeast Wall of Court 24, at the Left, Before Restoration



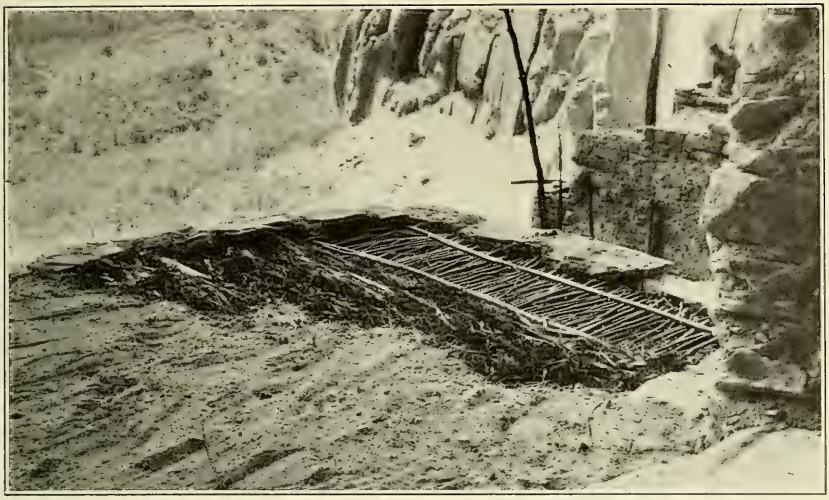
B. Two-story Room 66 and Near-by Buildings Stand at the Extreme Right



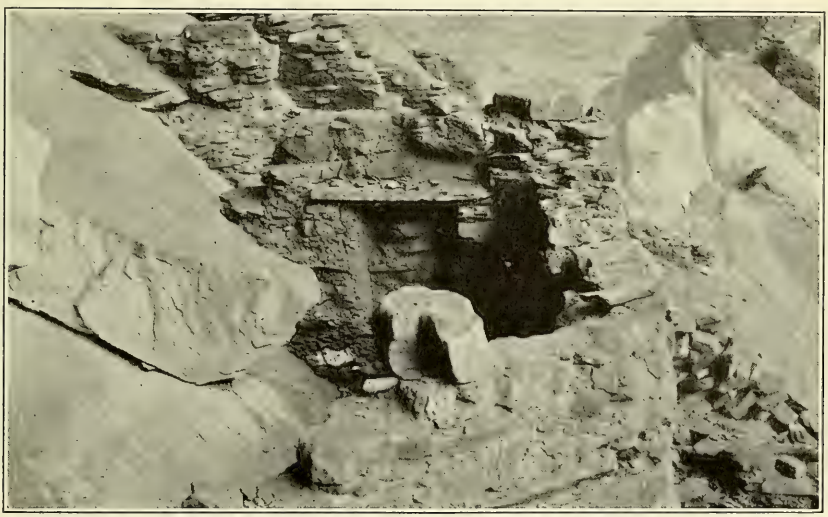
A. THE WATTLED NORTHEAST WALL OF COURT 28, FROM THE WEST



B. NAVAJO INDIAN REPAIRING THE WATTLED WALL OF COURT 24



A. WILLOWS, CEDAR BARK, AND SAND MADE A NEW ROOF FOR ROOM 31

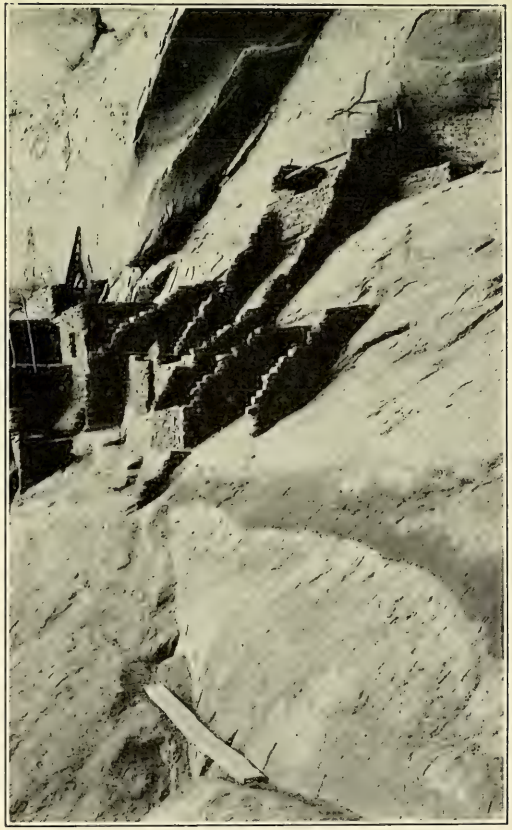


B. ROOM 44, FROM THE WEST; BEYOND, THE LOWER SEEPAGE ZONE AND TRAIL

A. REPAIRING THE SOUTH WALL OF ROOM 48. VIEW TAKEN FROM ROOM 47

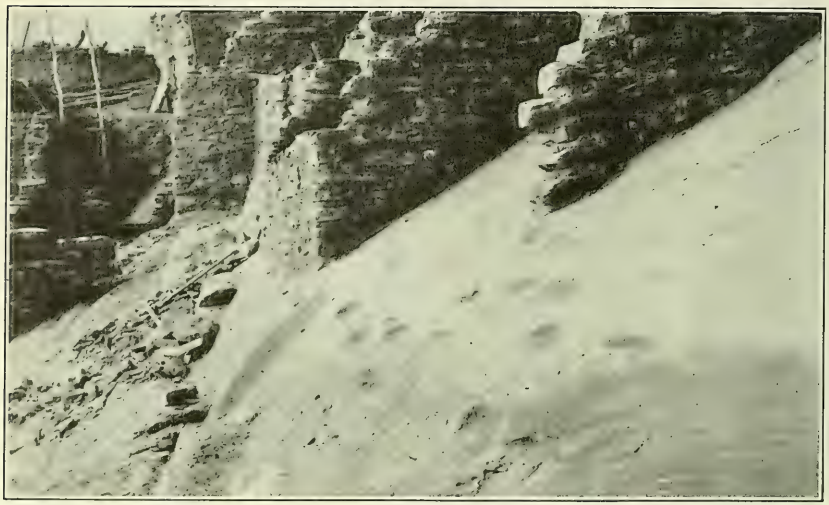
B. THE NORTHEAST WALL OF COURT 45 ENDED IN A CHANNEL, PECKED IN THE CLIFF

A. THE CENTRAL HOUSE CLUSTER, FROM ROOM 75. IN THE MIDDLE DISTANCE, TWO MEN STAND IN ROOM 51

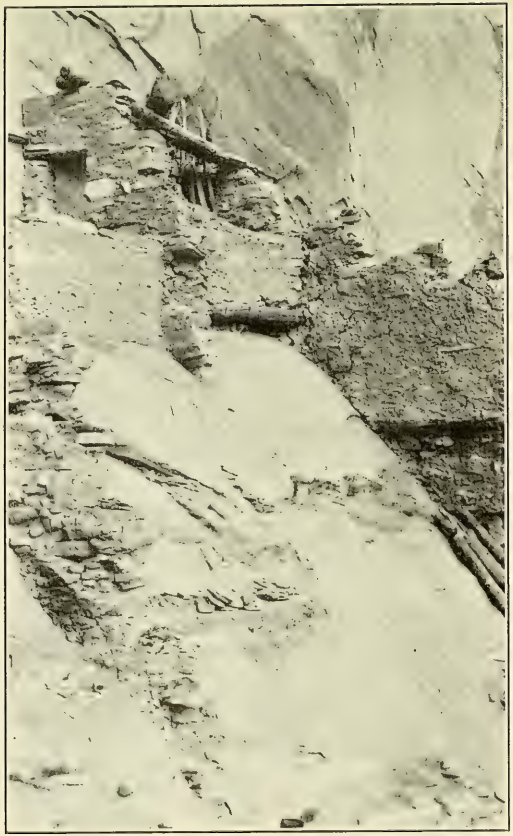


B. BLOWN SAND SOON SETTLED ON THE BARED SEEPAGE ZONE ABOVE THE MAIN CROSS-CAVE TRAIL

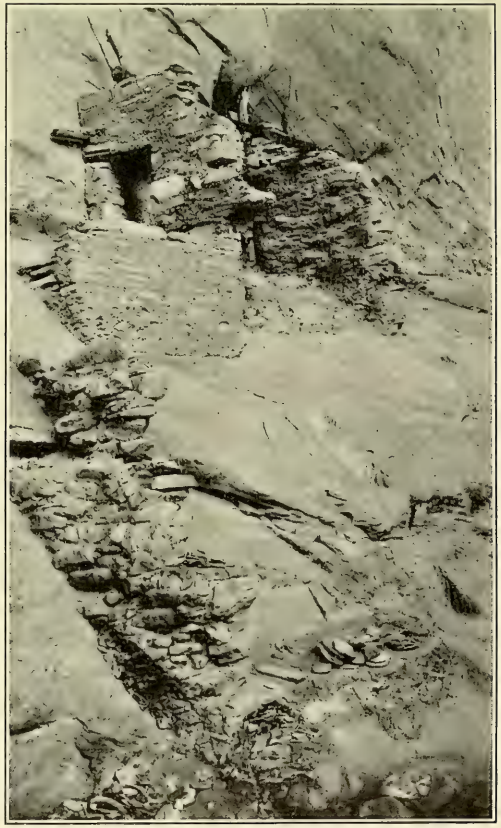
A. The Northwest Wall of Rooms 64–65 (which later collapsed) with Beam Holes Marking the Floor Level of the Second-Story Chamber



B. Many Betatakin Walls Were Erected Upon Such Shallow, Pecked Steps as These, at the Southeast End of Rooms 101–102



A. PLATFORM 58 AND ROOM 59 STAND ABOVE THE SLOPING SITES OF ROOMS 57 AND 60

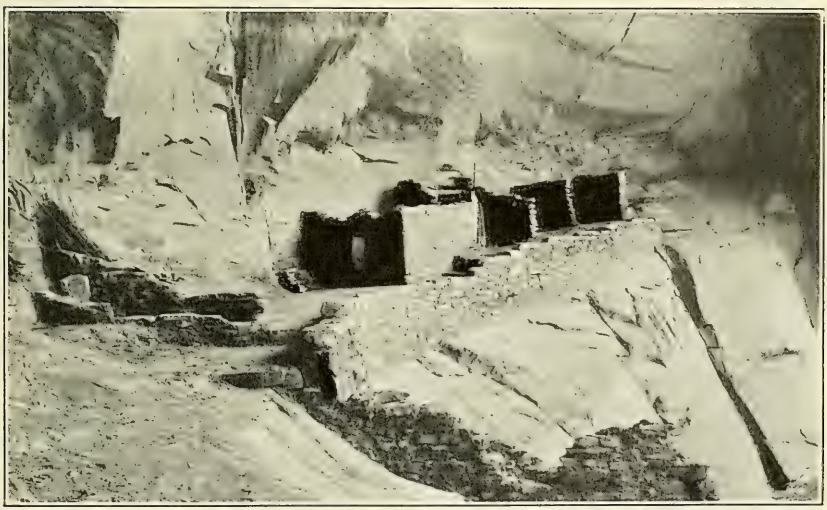


B. AT THE RIGHT, NEW WALL RESTS AWAIT RECONSTRUCTION OF ROOMS 60 AND 64

A. RECONSTRUCTING THE NORTHEAST WALL OF ROOM 60

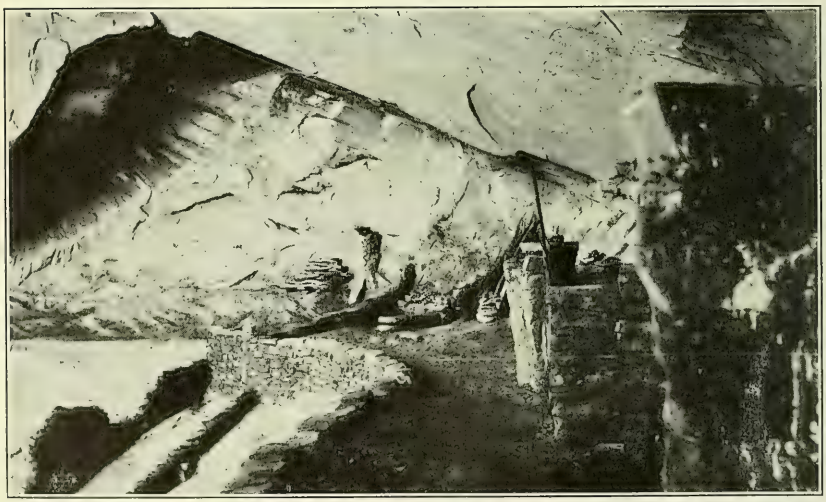
B. THE PARTIALLY RESTORED WALLS OF ROOMS 56, 57, AND 60

A. The Upper East House Group Before Excavation. Room 78 Shows Prominently in the Middle Distance

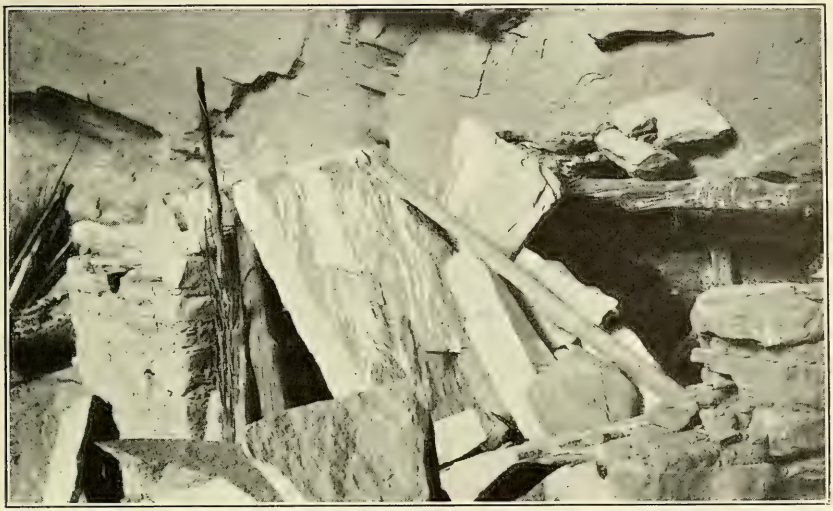


B. Rooms 78–81, After Restoration. In the Right Foreground, the Repaired West Wall of Rooms 76–77

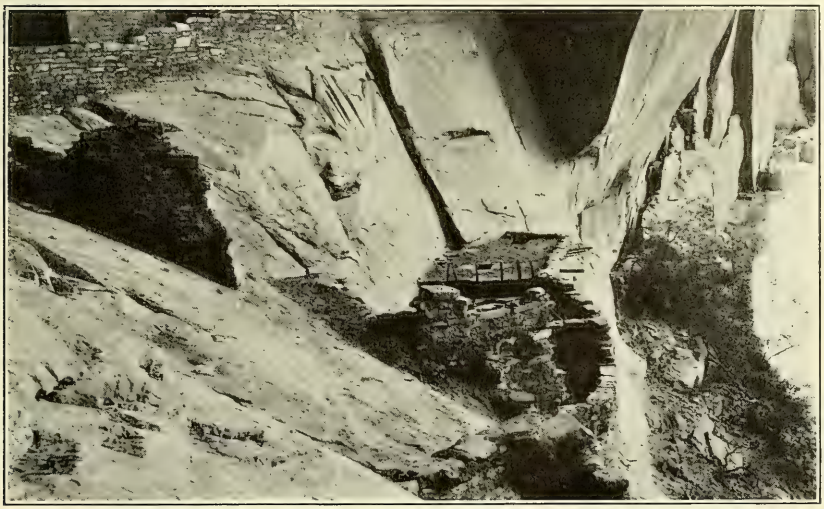
A. HOUSES OF THE NORTHEAST GROUP HAD BEEN DEMOLISHED BY HUGE BLOCKS OF FALLEN SANDSTONE AS THIS VIEW, FROM ROOM 81, PLAINLY SHOWS



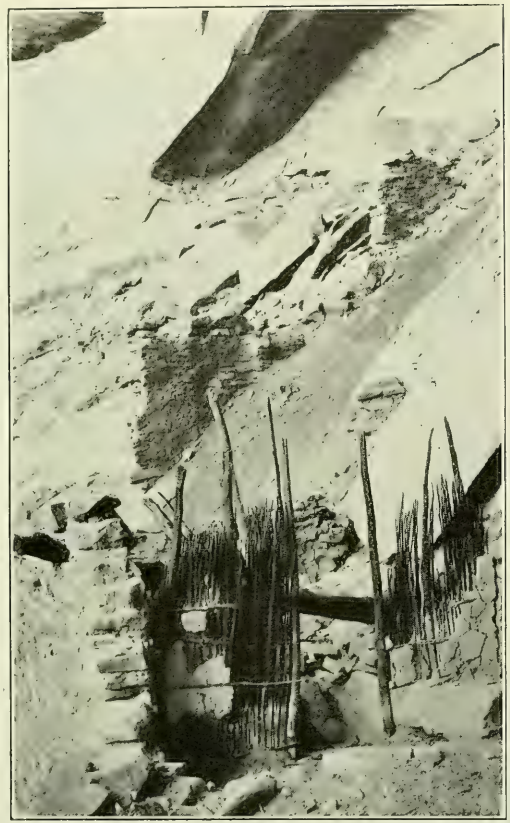
B. IN THE FOREGROUND, THE RESTORED WALK FRONTING ROOMS 78–81; AT THE LOWER LEFT, THE SIDE WALLS OF ROOMS 76–77



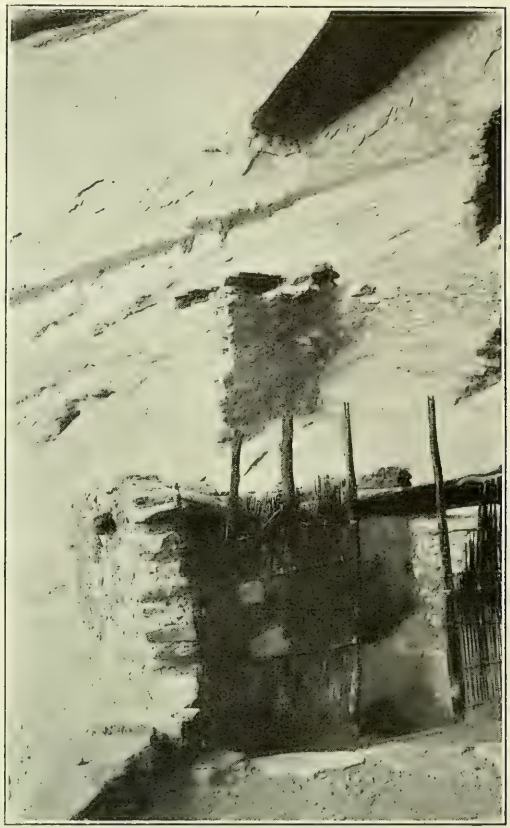
A. Massive Sandstone Slabs Had Crushed the Roof of Room 79



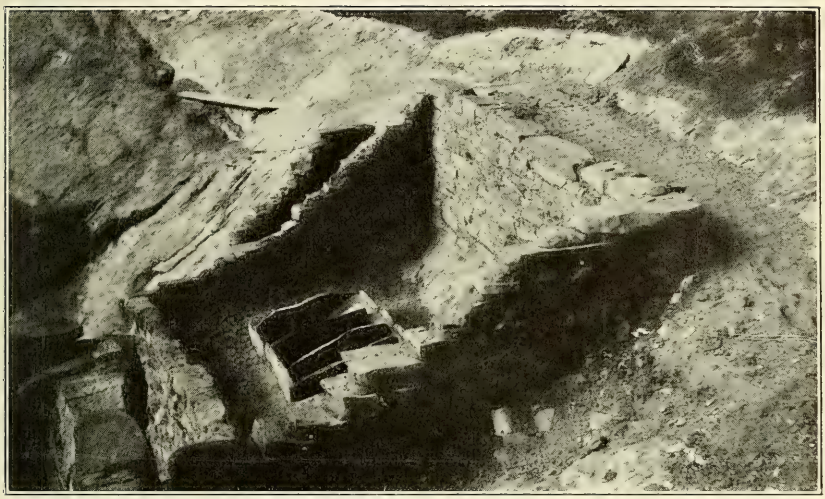
B. The East Retaining Wall Looks Down Upon Rooms 82–85



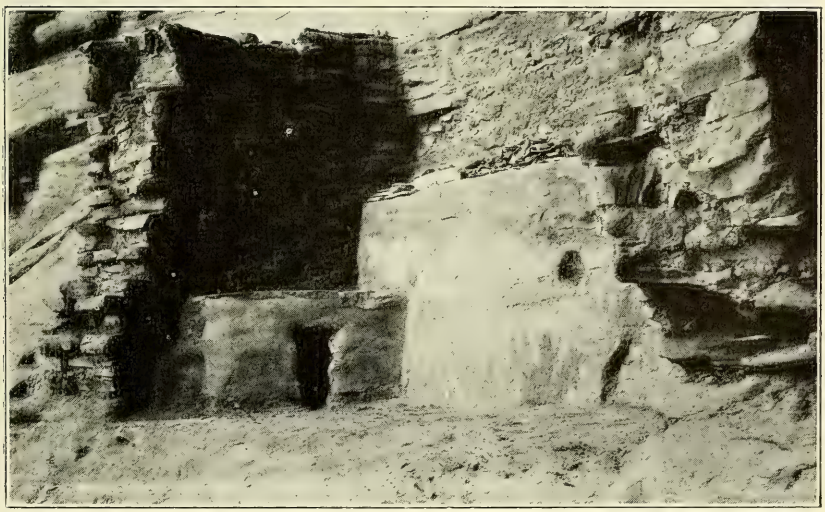
A. THE WATTLED EAST WALL OF ROOM 82 AND, BEYOND, THE BROKEN WEST MASONRY OF ROOMS 75–76



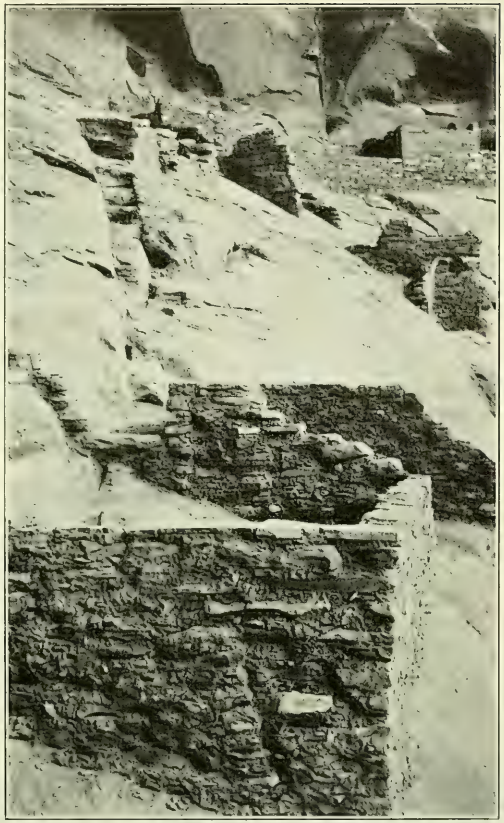
B. PECKED GROOVES AND STEPS ON THESE BARED SLOPES EVIDENCE THE FORMER PRESENCE OF OTHER DWELLINGS



A. Walls and Mealing Bins of Room 117, Restored; Above, the Principal Cross-cave Trail



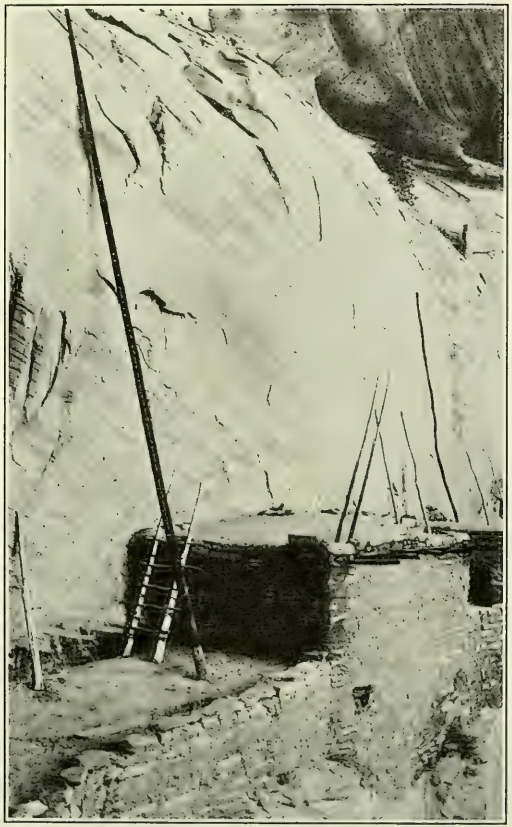
B. The Plastered North Shelf and Corner Bench in Room 55, Viewed from the East



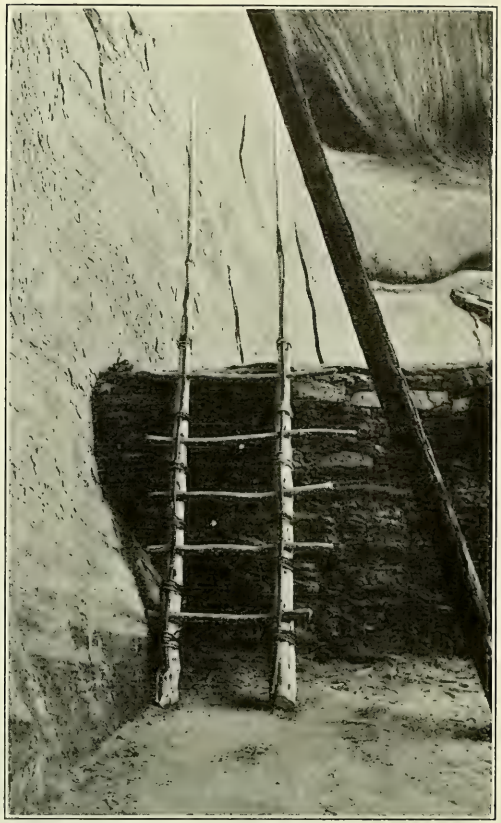
A. In the Foreground, Restored Room 122; at the Upper Left, Room 73 Stands on the Old Stepped Trail

B. For Repairing the East House Group, Mud Was Dragged Up the Slope from Court 83

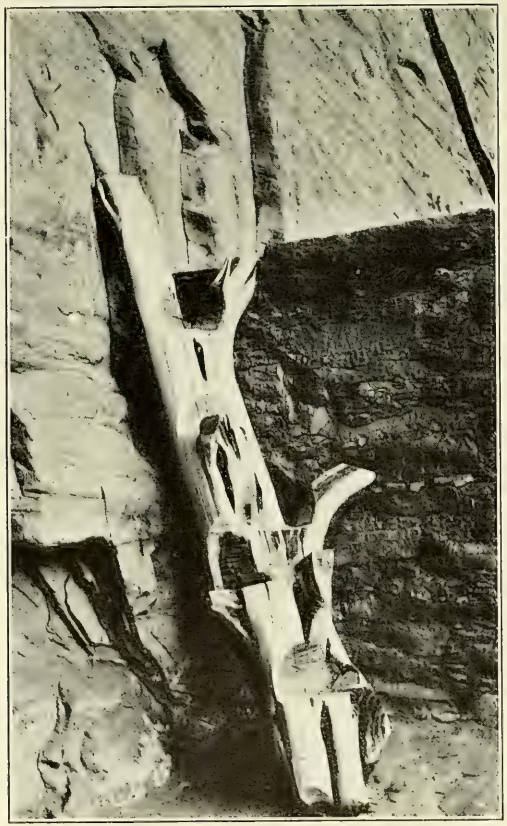
THE EASTERN HOUSE GROUP OCCUPIED TWO SEPARATE TERRACES AND THE SLOPE BETWEEN. RESTORED ROOM 117, AT THE LOWER LEFT. (1926 PHOTOGRAPH, BY COURTESY OF DR. A. E. DOUGLASS)



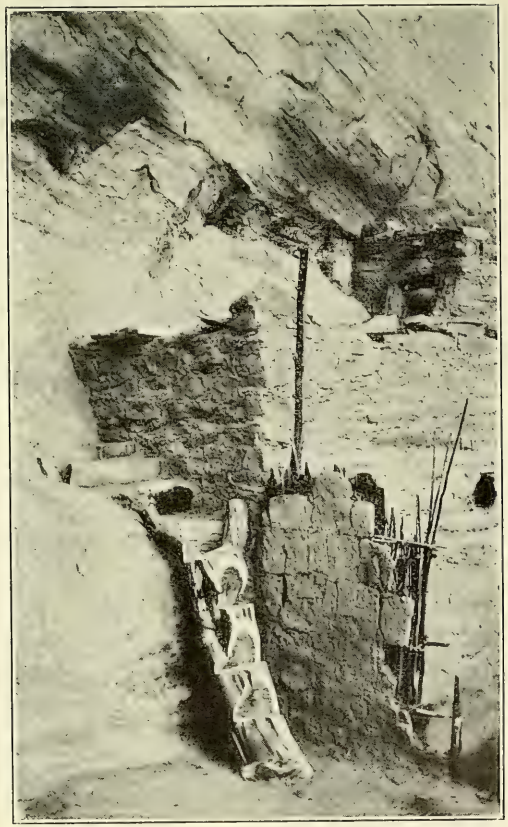
A. A Slender Pole Formerly Provided Access to the Gallery Ledge



B. In Court 10, a Ladder Replaces Steps Pecked in the Cliff



A. A Notched Cedar Now Stands in the North Corner of Court 13



B. Ladder and Stone Steps at the North Corner of Court 24

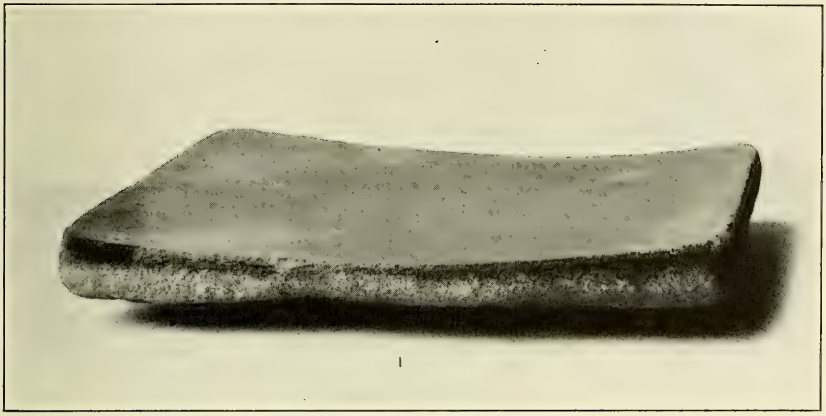
A. VIEW FROM COURT 28, ACROSS THE SOUTH WALL OF ROOM 39 TO ROOMS 1–3, IN THE FAR CREVICE

B. WISE EXPLORERS WILL INDULGE A COOK'S WHIM FOR GLOVES AND SPANISH SPURS

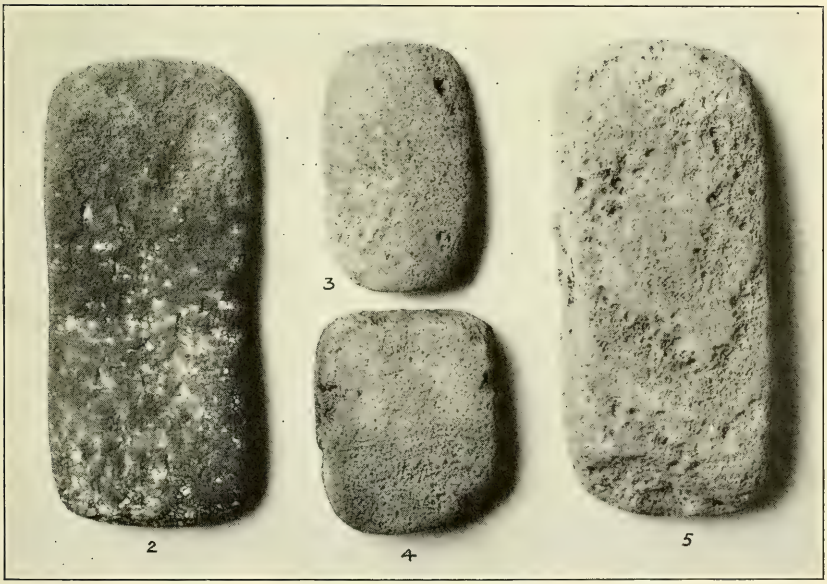
A. PAINTED FIGURES ON THE CLIFF ABOVE ROOMS 89–90

B. ROOMS 86–89, FROM THE NORTH END OF ROOM 90

ACROSS THE CANYON FROM BETATAKIN IS AN INCIPIENT CAVE, TOO SHALLOW FOR HUMAN OCCUPANCY (1926 PHOTOGRAPH, BY COURTESY OF DR. A. E. DOUGLASS

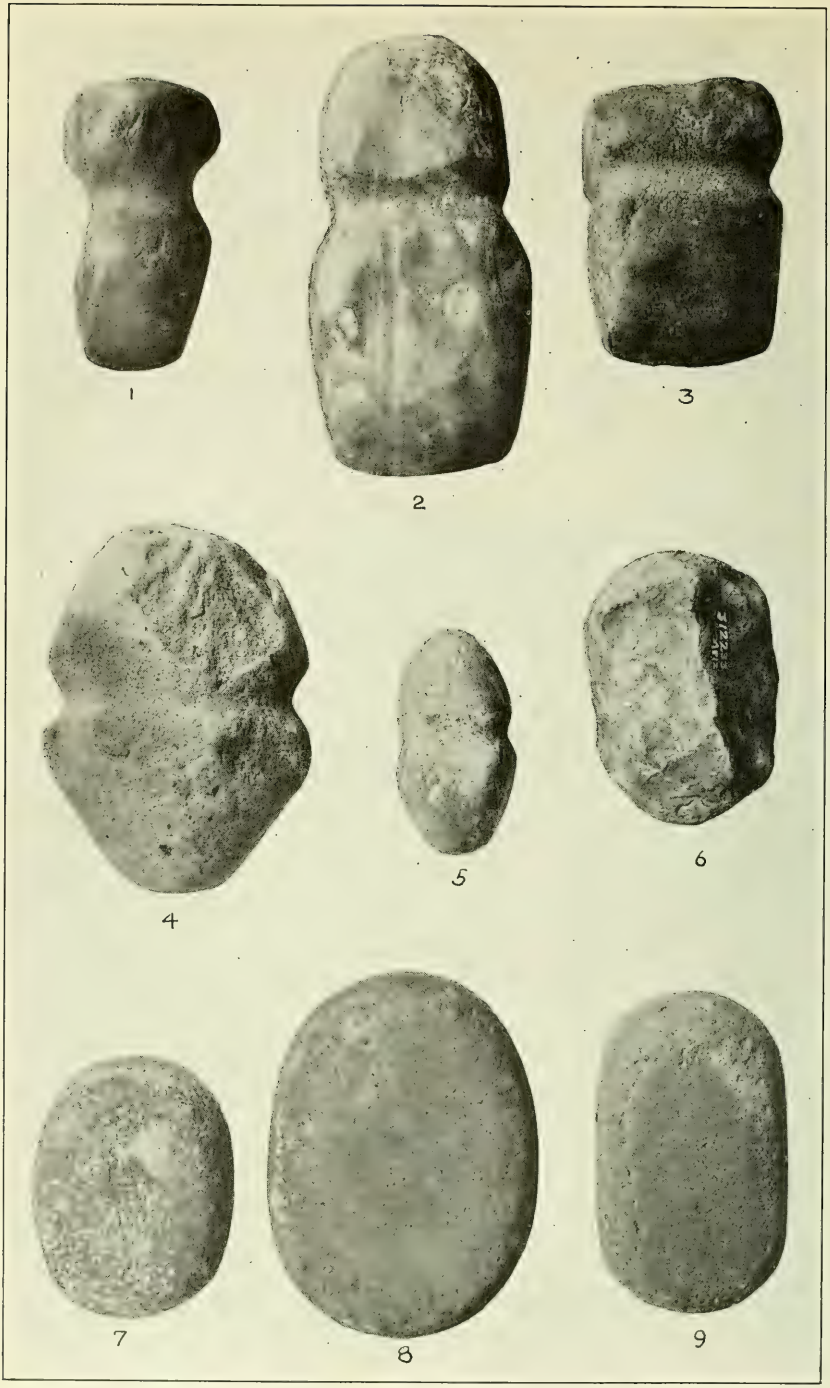


METATE OR MEALING STONE



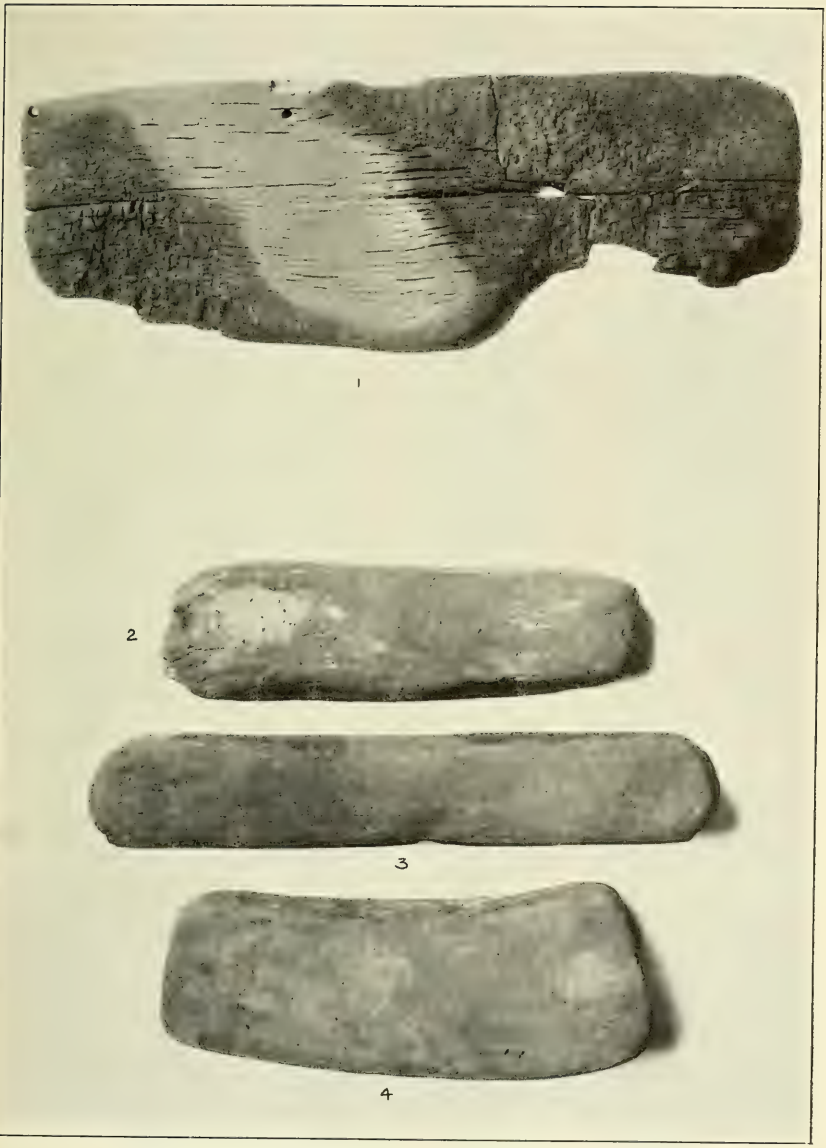
MANOS, OR HAND STONES, USED ON METATES

FOR DESCRIPTION SEE TEXT



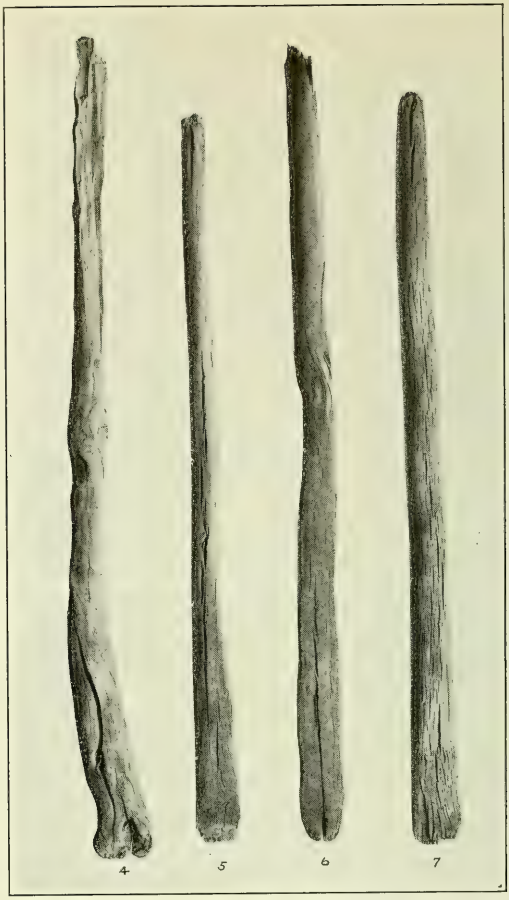
AXES, MAULS, AND SMOOTHING STONES

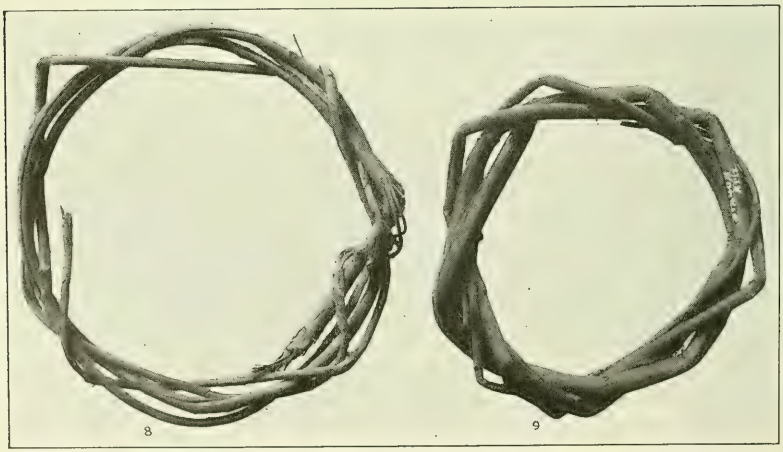
FOR DESCRIPTION SEE TEXT.



DRILLED OAK BOARD AND BILLETS OF COTTONWOOD

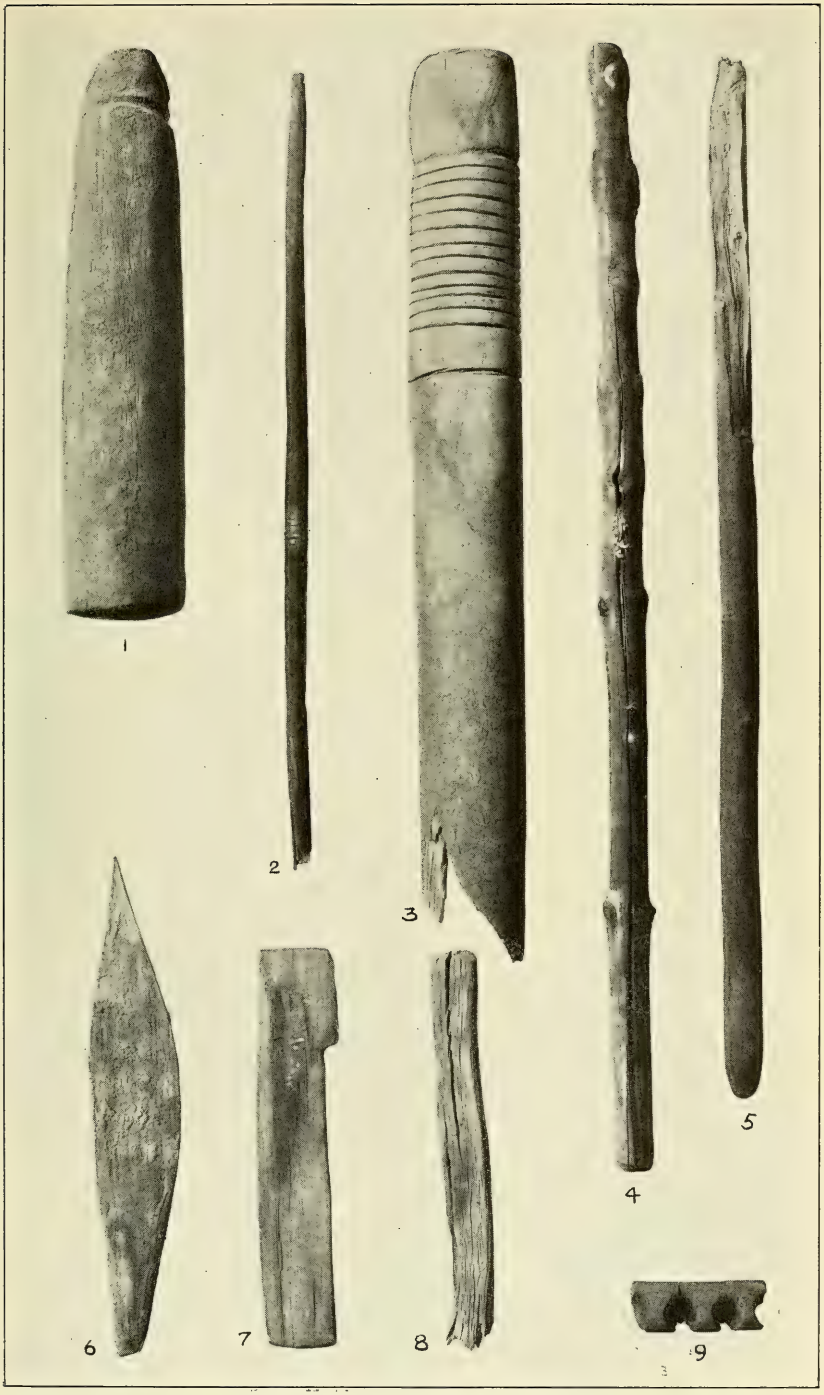
FOR DESCRIPTION SEE PAGE 000.





COTTONWOOD STAVES, OAK DIGGING STICKS, AND WILLOW POTRESTS

FOR DESCRIPTION SEE TEXT.



MISCELLANEOUS ARTIFACTS OF WOOD

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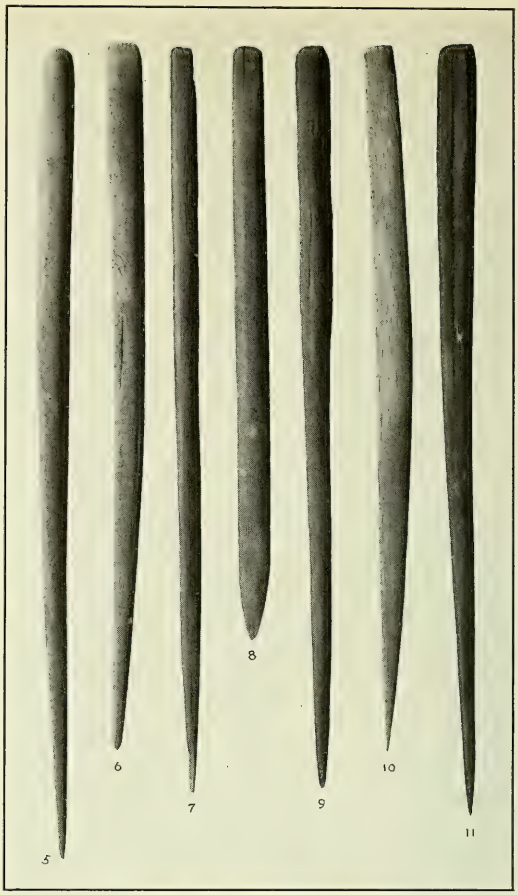
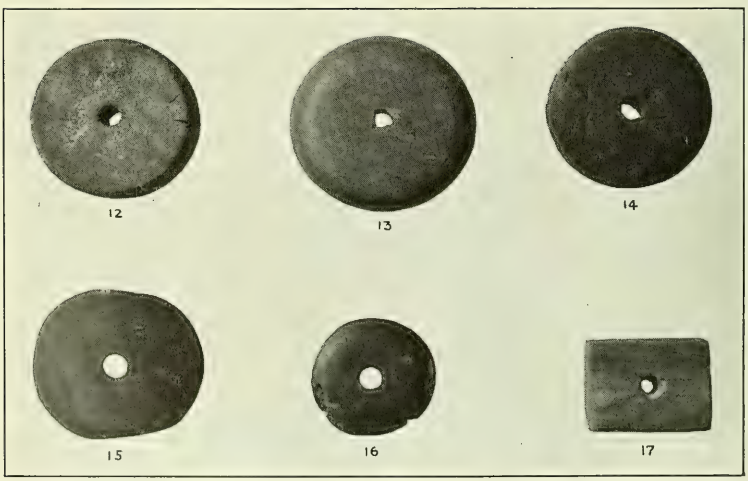
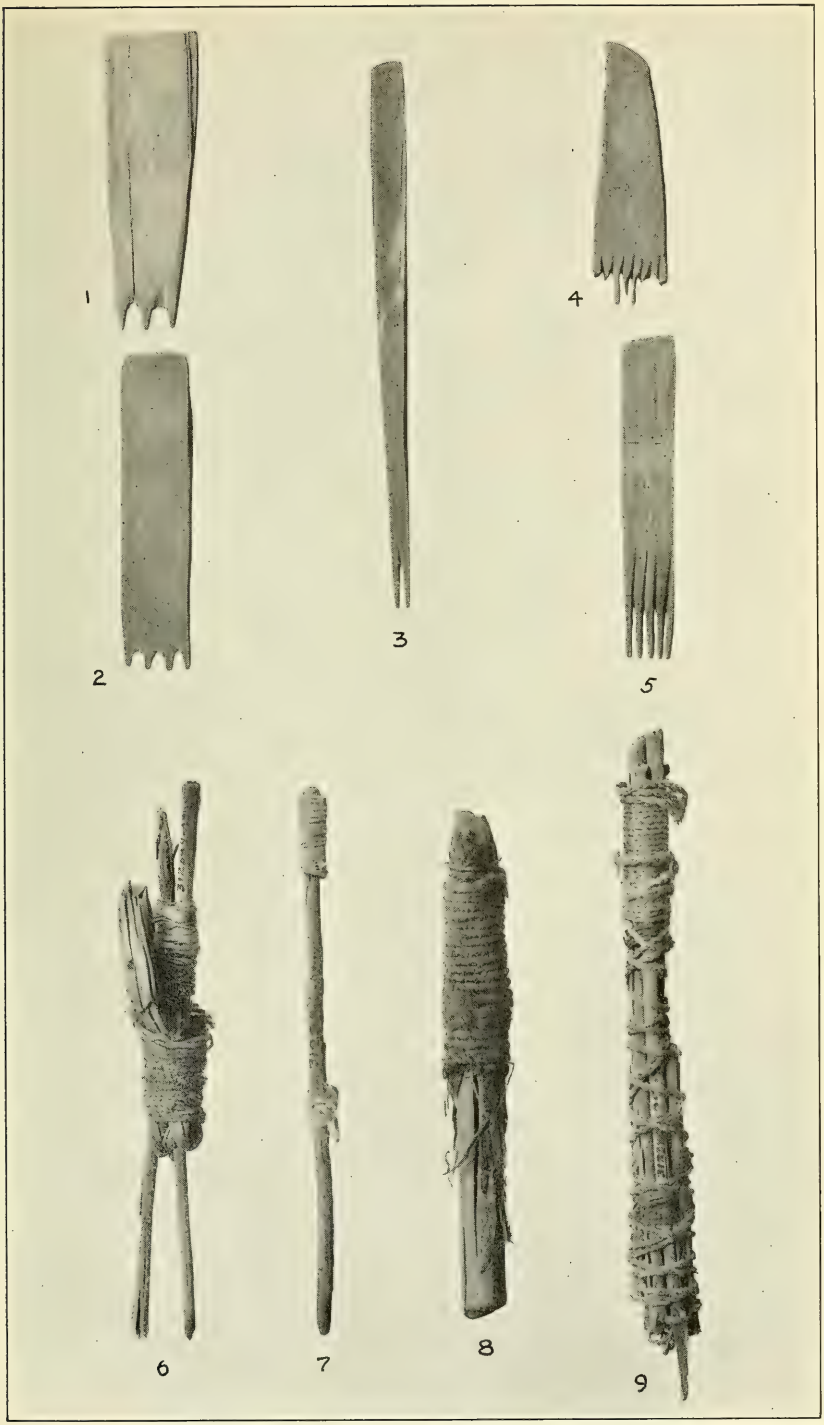




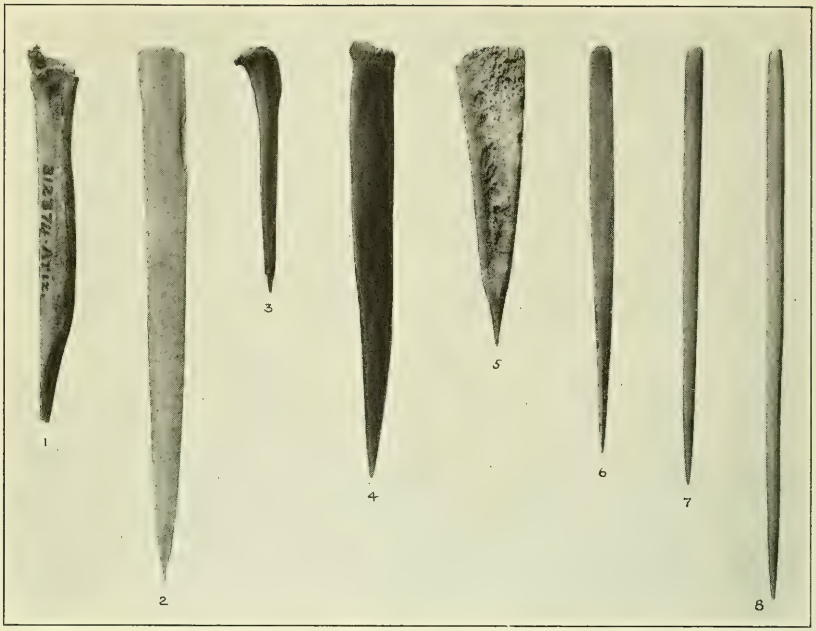
DRILL, WOODEN AWLS, SPINDLE SHAFTS, AND WHORLS

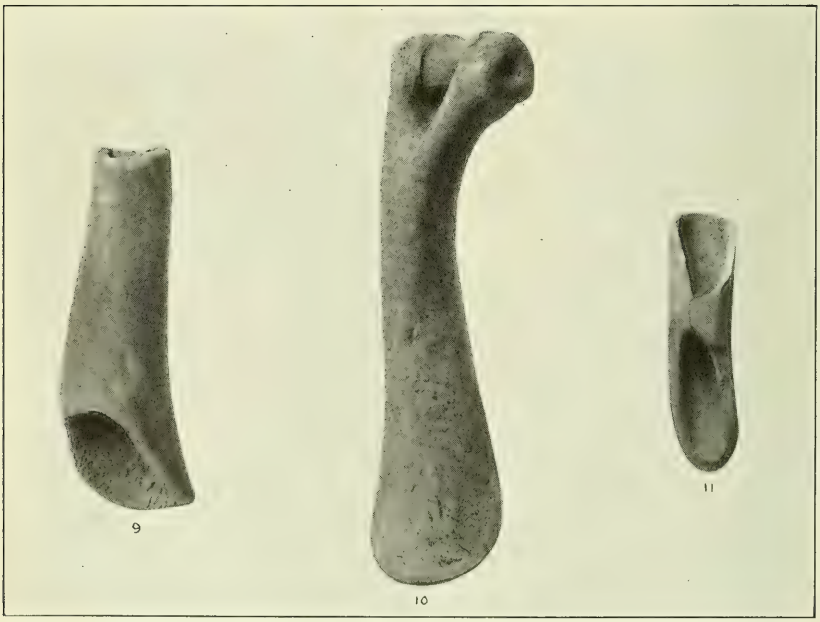
FOR DESCRIPTION SEE TEXT



TOOTHED IMPLEMENTS AND CORD-WRAPPED STICKS

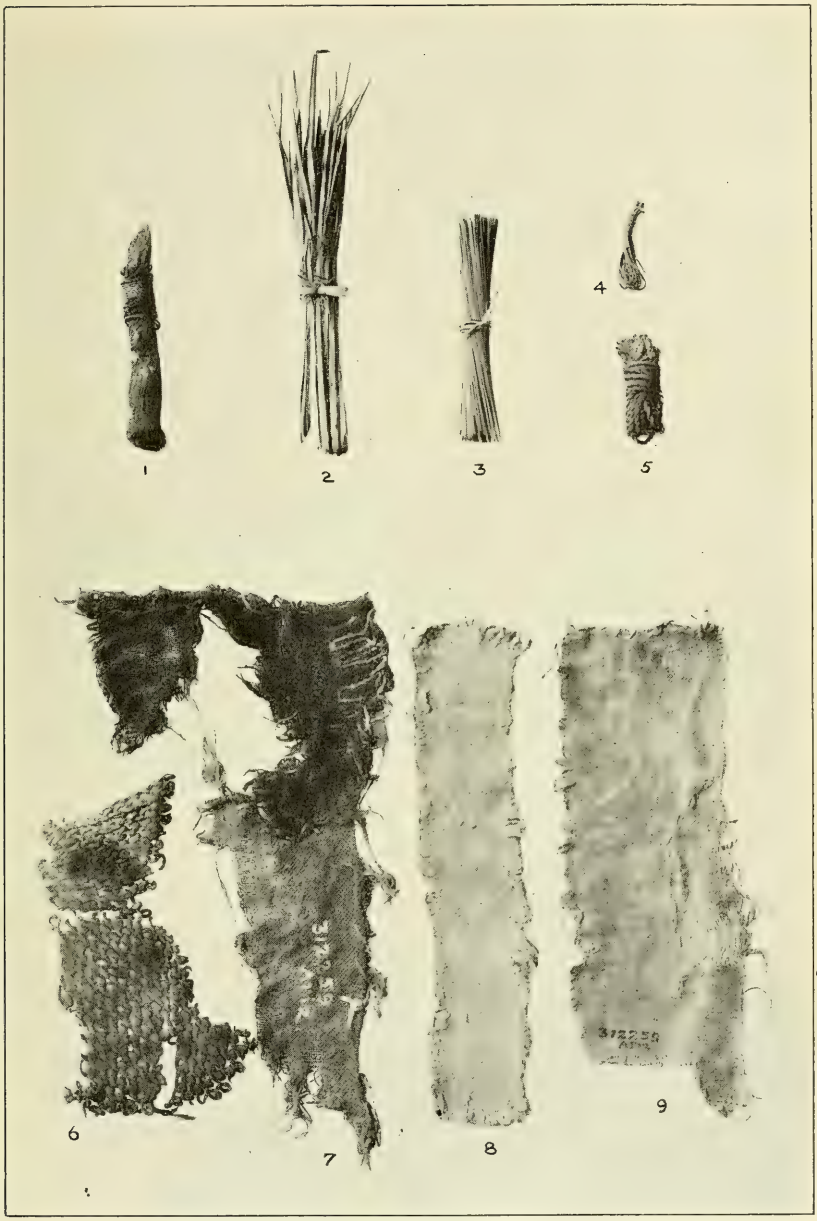
FOR DESCRIPTION SEE TEXT.





BONE AWLS AND SCRAPERS

FOR DESCRIPTION SEE TEXT



BRUSHES, CORD, AND COTTON RAGS

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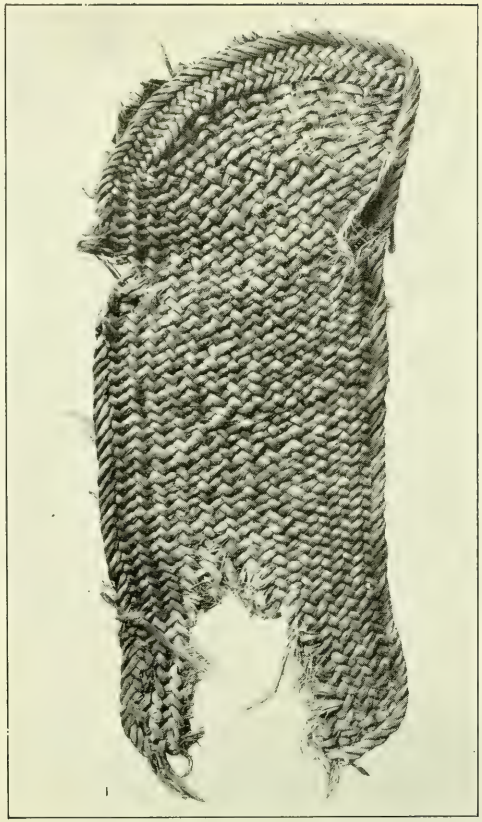
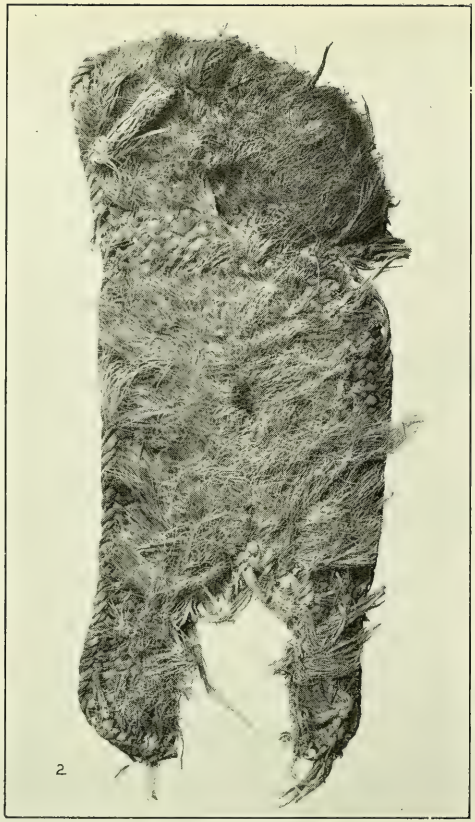
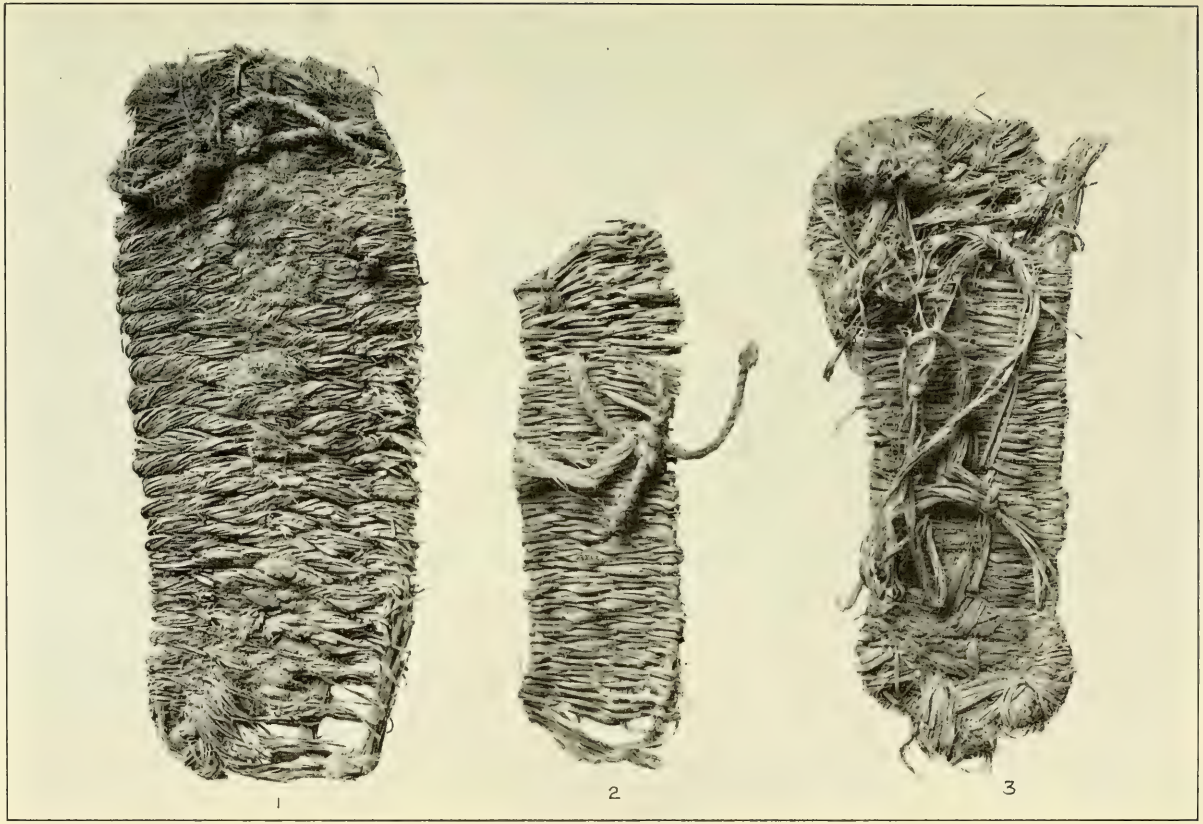




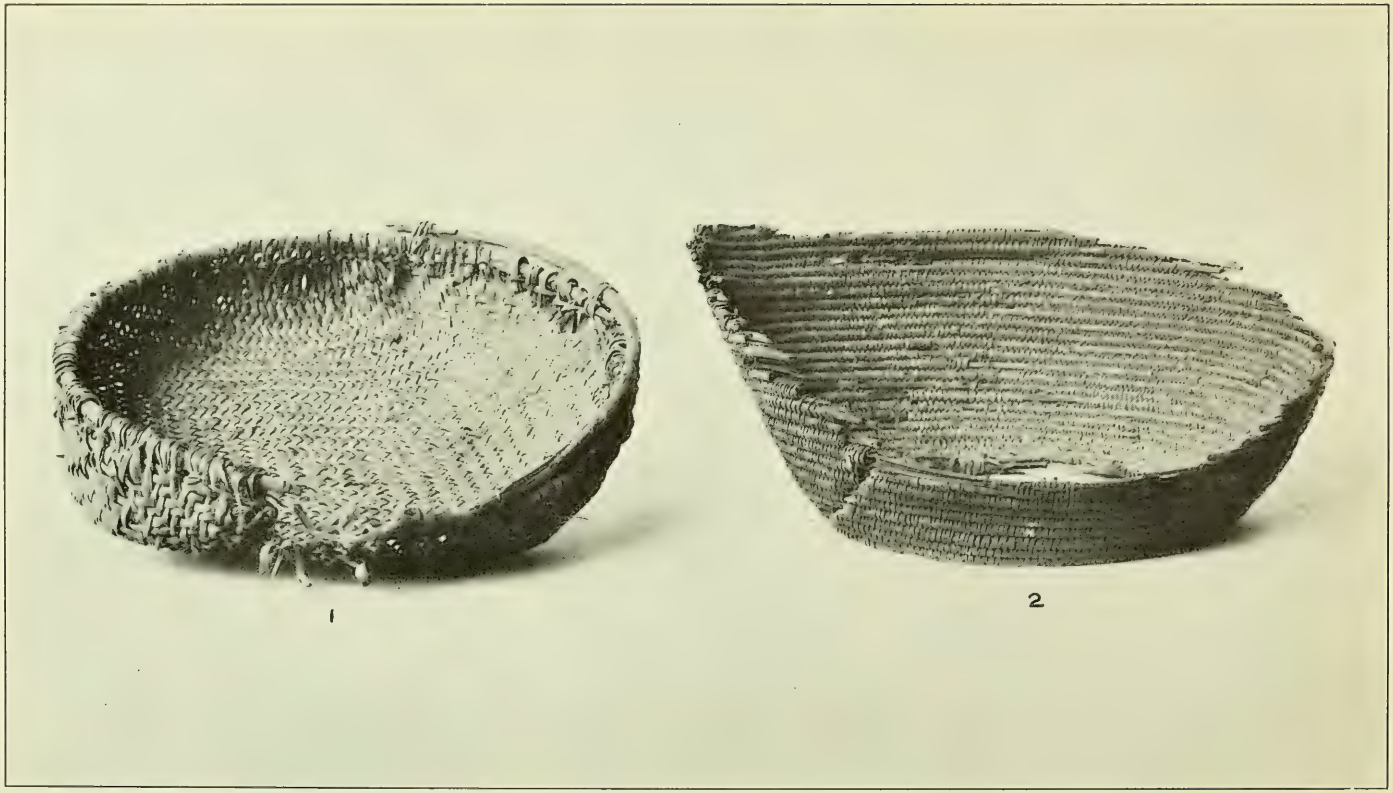
TWILLED SANDALS (*1* AND *2* SHOW THE SAME SPECIMEN, TOP AND BOTTOM VIEWS)

FOR DESCRIPTION SEE TEXT.



WICKERWORK SANDALS

FOR DESCRIPTION SEE TEXT



1

2

BASKETS

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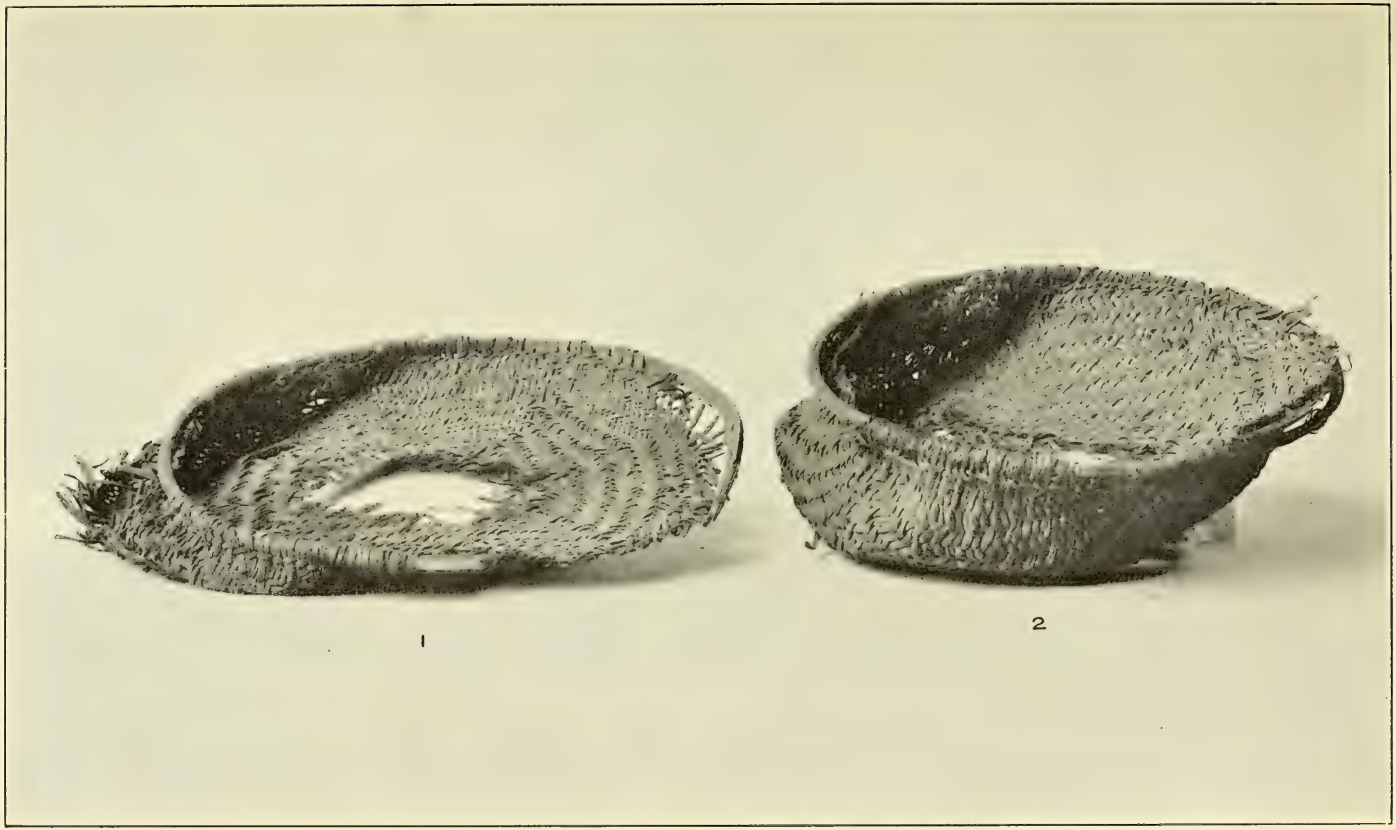

TWILLED BASKETS

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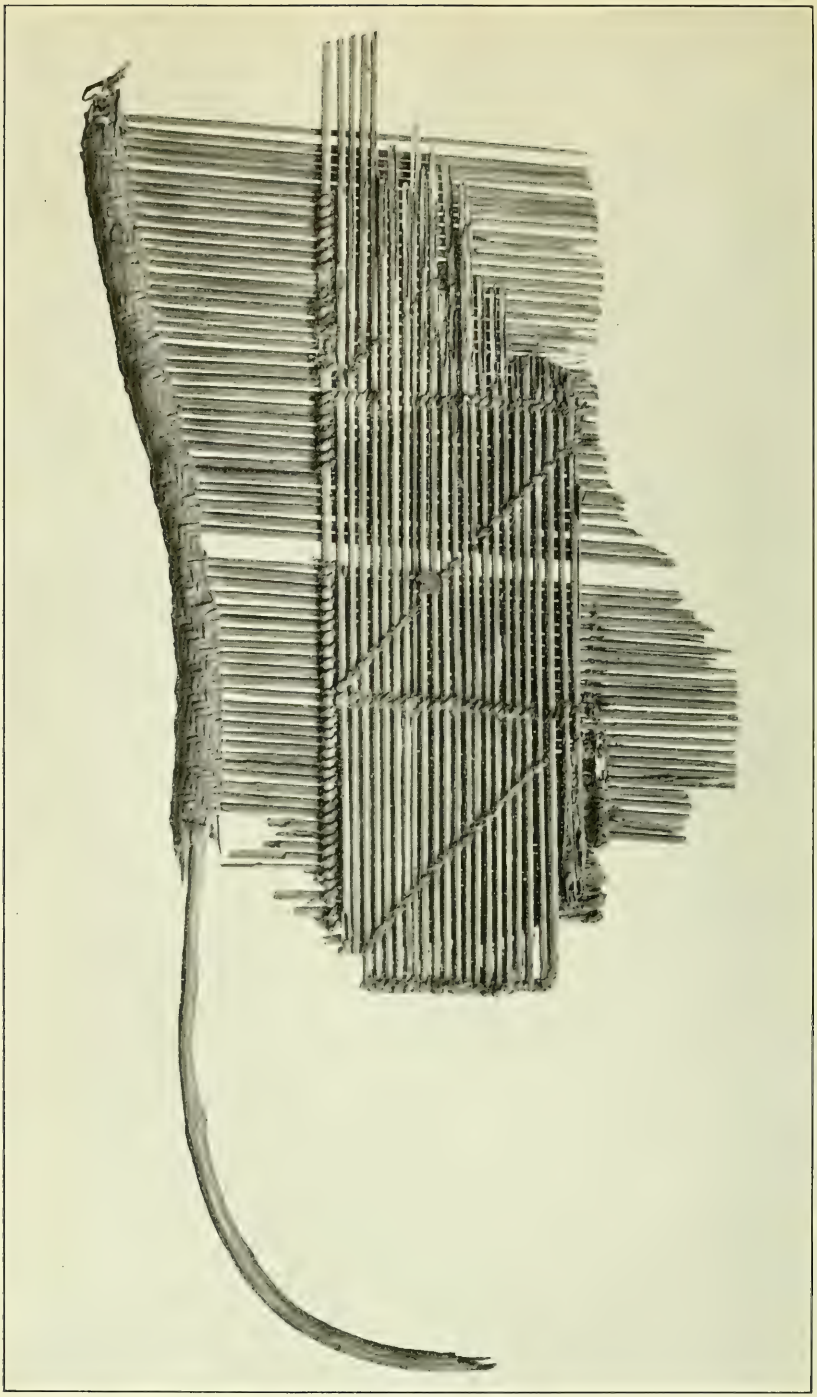
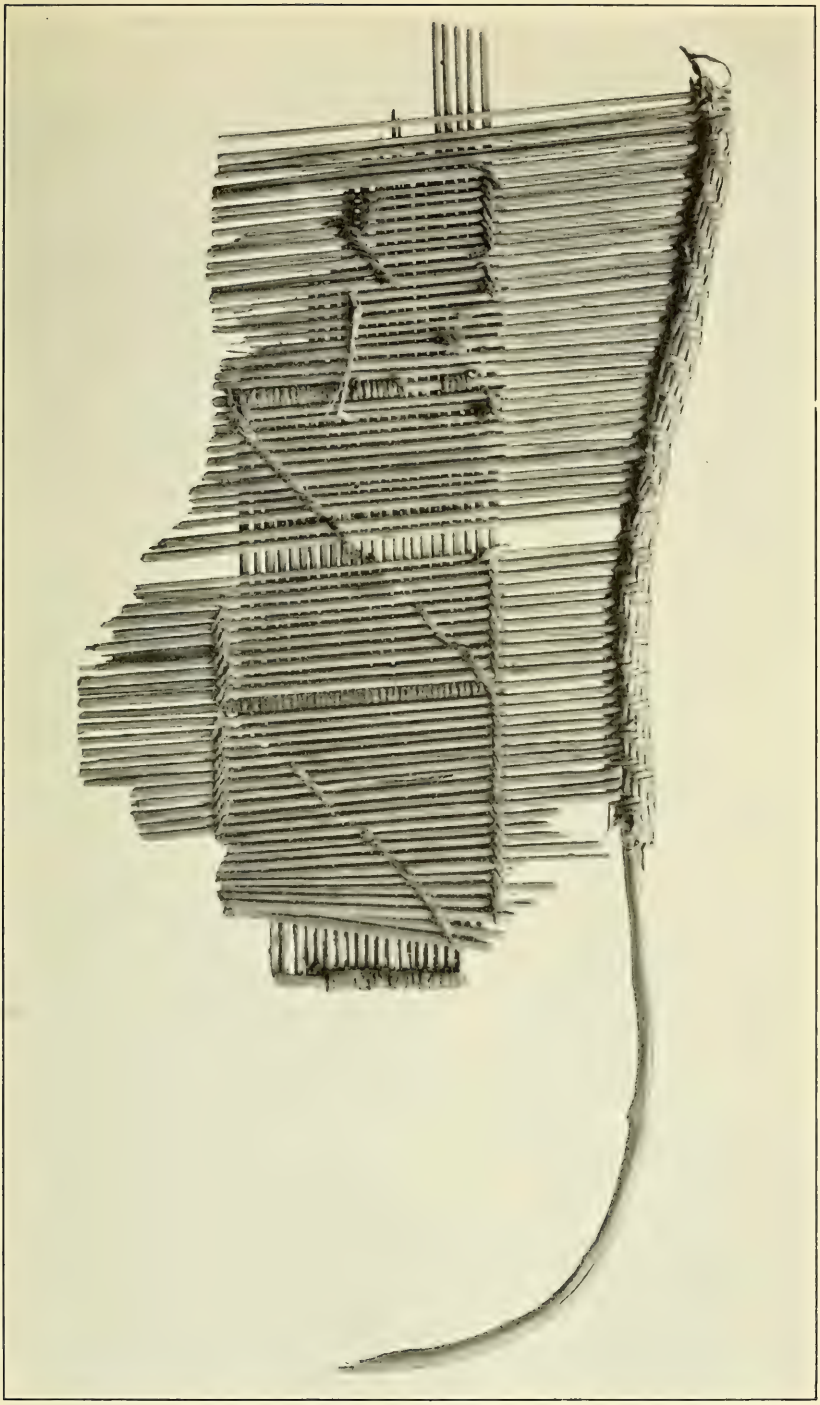


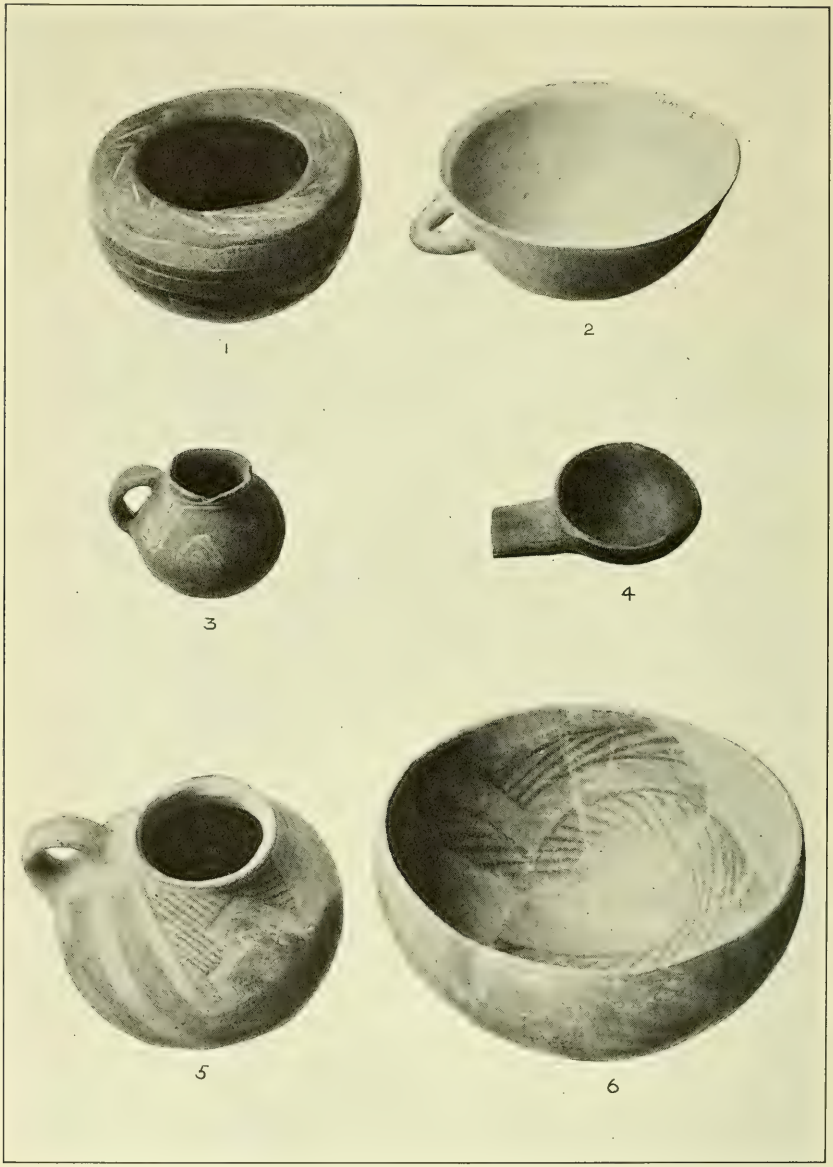
CRADLE—FRONT VIEW

FOR DESCRIPTION SEE PAGE 65.



CRADLE—BACK VIEW

FOR DESCRIPTION SEE PAGE 66.



EARTHENWARE VESSELS

FOR DESCRIPTION SEE TEXT.

A MONOGRAPH OF THE FORAMINIFERAL FAMILY POLYMORPHINIDAE, RECENT AND FOSSIL

By Joseph A. Cushman, *of Sharon, Massachusetts*
and
Yoshiaki Ozawa,* *of the Imperial University of Tokyo*

INTRODUCTION

The Polymorphinidae, like many other families and groups of Foraminifera, are in a state of confusion that makes it difficult to identify species on account of the great number of forms figured under the same name. Many names have also been given to the same species. Brady, Parker, and Jones, in 1870, reviewed the subject in their work, A Monograph of the Genus Polymorphina, and Jones and Chapman later dealt at some length with the fistulose forms.

We finished, two years ago, a preliminary study of the family introducing a new classification of the group, based on the relationships as worked out in a joint study of many species. Some of the results of this study have been published: An Outline of a Revision of the Polymorphinidae,[1] Some Species of Fossil and Recent Polymorphinidae Found in Japan, and A Revision of Polymorphinidae.[2]

Since the completion of the first studies we have both spent some time in Europe studying collections and collecting and preparing material, the results of which are embodied in the present paper after a further six months' study together of the material brought together in our combined collections.

We found that the published figures for the most part were not accurate enough in their details to be reliable in many cases, and except for a study of the available type specimens the study of our own abundant material has been the main source of our conclusions. Nevertheless the type figure and description have been studied in all

* While this paper was in press, notice of the death of Doctor Ozawa in Tokyo on December 29, 1929, was received. The correction of proof is therefore entirely mine, with the exception of some few notes I received from Doctor Ozawa after his return to Japan, where he again went over the duplicate manuscript. It is to be regretted that he was not able also to examine the proofs, for his keen mind would undoubtedly have found errors that I have probably overlooked.

Through the characteristic generosity of Doctor Ozawa, my collection at Sharon was made the depository of nearly all the types and slides of all the species and varieties from the various localities. This collection, which will eventually find its way to the U. S. National Museum, is therefore exceptionally complete for this family, which occupies considerably more than a thousand slides and many thousands of specimens.—Joseph A. Cushman.

[1] Contr. Cushman Lab. Foram. Res., vol. 4, 1928, pp. 13–21, pl. 2.

[2] Jap. Journ. Geol. Geogr., vol. 6, 1929, pp. 63–83, pls. 13–17.

cases, usually with a study of topotype material at the same time. We have been exceptionally fortunate in having abundant material from nearly all the important type localities of Europe and elsewhere, so that the species that we have actually seen from their type localities represent a large part of the total number. Many persons and institutions have supplied us with material, and all can not be thanked individually. We have ourselves collected at many of the type localities. In Vienna, for example, Ozawa washed down more than a quarter of a ton of clays from the type localities of Baden and Nussdorf, with the result that we have had for study beautiful suites of specimens of species from these important localities. Of the localities of England, France, Italy, Spain, Belgium, Holland, Germany, Austria, Hungary, etc., we have also had abundant material. From Japan, Australia, Fiji, New Guinea, etc., material has been abundantly supplied as well as from northern South America, Trinidad, Mexico, and the United States. Altogether we have studied material probably from more than a thousand localities, and the number of mounted specimens totals many thousands. We have had for study therefore an exceptional collection, and the results of our study, while not in any sense final, will nevertheless have the satisfaction of being based on abundant material from type localities.

DISTRIBUTION

In the present work it has been found useless to try to check up the distribution of species from the published records. So many of the species have been wrongly used and so many of the records are unaccompanied by figures that the resulting confusion can only be straightened out by an actual study of the existing collections on which these records were based. Such a study at this time is impossible. For these reasons we have used the specimens available to us and the notes made in studies of European collections.

Even with the many thousands of mounted specimens of Polymorphinidae that we have, it will be found that the ranges both geographically and geologically are probably not entirely correct for some of the species. The distribution of species as we have identified them was plotted in colors on a world map so that the distribution of each species as we have identified it might be quickly seen.

The maps show one thing in particular that was already apparent from our study of many specimens; that is, that smooth, rather primitive species such as *Globulina gibba* and *Guttulina problema* have a very long geologic history and are widely distributed. On the other hand, a similar study of the maps of the species of *Polymorphina* shows that they are each restricted to narrow limits both in present oceans and in the fossil series. In the latter, we are dealing with species of a genus that is specialized and has developed most of its species in the late

Tertiary and in the present seas. Similarly, it will be found that some of the species of various genera that are highly ornamented or have very characteristic shapes do not range widely, while smooth forms of the same genera for the most part have very much greater ranges. We have recognized this fact, and it is possible in our material to indicate several groups under a single specific name with more restricted ranges, but it was found very difficult to show these differences so that they would be really of use to the worker in the group. Some of these forms undoubtedly overlap in their characters, yet those of given areas or formations may have minor characters which are distinctive when the specimens themselves are studied.

With the smooth Polymorphinidae, especially in the more primitive species of *Guttulina*, the limits of variation are very difficult to definitely fix, and young stages are also usually perplexing. Forms that seem distinct in two areas may have connecting forms which bridge the gaps, and all are placed together. It will probably be possible with intensive work on restricted areas to definitely fix the limits of variation in different species much more clearly than can be done at the present time.

Microspheric and megalospheric forms, even in the same area or formation, are often considerably different in certain characters, and when the full characters of the two forms are known in each species the distribution will probably be restricted.

Some distributions as shown by well-defined species are very interesting. Some of these are already well known from other groups of the foraminifera. There are, of course, many areas in which there have developed specialized species, very restricted in their distribution and characterizing that particular area or horizon. Many such examples will be found in the species given here, and a few only need be mentioned: *Guttulina regina* with a restricted Australian-East Indian range, a very striking species difficult to mistake; *Polymorphina advena*, Oligocene of the Mint Spring marl of Mississippi; *P. alleni* of the Eocene of England; *P. burdigalensis*, Miocene of Europe; *P. complanata*, Miocene of Nussdorf; *P. cushmani*, lower Eocene, Midway of Texas; *P. frondea*, lower Oligocene, Gulf Coastal Plain of the United States; *P. frondiformis*, Pliocene of Sutton, England; *P. longistriata*, lower Eocene, Thanet beds of Pegwell Bay, England; *P. parallela*, Pliocene of St. Erth, England; *P. subrhombica*, Eocene of New Jersey. These are well-characterized species, and their absence in other regions is due to restricted distribution and not to being overlooked. Some interesting relationships of rather remote regions have been noted. That the lower Oligocene of the Gulf Coastal Plain and the Miocene and living faunas of the Australian region are closely related has been often mentioned. The Pliocene and Recent faunas of the region of Japan and southern

California are closely related, and a number of species are common to the two areas both fossil and Recent: *Guttulina orientalis, Polymorphina charlottensis,* and others. The Miocene of the Florida region and that of central Europe have certain species in common. The Eocene of the Paris Basin and allied areas are related to that similar age in America and the Miocene of Australia. The Tortonian Miocene of central Europe is related to the Pliocene of Italy and to the Recent fauna of the Mediterranean. Some of the Oligocene species of Germany are very close to or identical with those of the Cooper marl, upper Eocene of South Carolina, but not equally related to those of the Jackson of the Gulf Region.

An interesting relation is that shown between the living fauna of the Carolina coast and that of the warm area of the Philippines, for example, not in shallow-water forms but in those of a hundred fathoms or more.

The fossil fauna of Trinidad has some very peculiar relationships with those of other regions. Some of the species of the Trinidad Eocene are much like those now living in the Philippine region, and in many respects the fauna has an Indo-Pacific relationship.

The Cretaceous faunas of Europe and America, especially of Mexico and the United States, have much in common. Yet each area in addition to species in common has certain specialized species of its own.

One of the interesting facts in regard to distribution brought out in our studies is the peculiar distribution of *Globulina.* While the genus was widely distributed in the Cretaceous and early Tertiary, it is much restricted in later times and in the present oceans. *Globulina gibba,* for example, while it is extremely common through the Miocene, becomes rare in the Pliocene and in the present oceans, not occurring at all in the Pacific and restricted to the Mediterranean and the Eastern Atlantic.

CLOCKWISE OR CONTRACLOCKWISE ARRANGEMENT OF CHAMBERS

In most of the Polymorphinidae the chambers are arranged, at least in the early stages, in a spiral, quinqueloculine or sigmoid series. In each of these series there are two different plans of arrangement; those are clockwise and contraclockwise. In the present paper a clockwise or contraclockwise arrangement of chambers is used in the sense of the direction in which each succeeding chamber is added when a specimen is viewed from the base. In a spiral species there is no difficulty in determining the direction of the spiral series. In those species having either a quinqueloculine or sigmoid arrangement of the chambers they are separated into two series for purposes of convenience. Therefore in this case the term clockwise or contraclockwise series is based on the direction of the arrange-

ment of chambers in each series. Accordingly if a species with either a quinqueloculine or sigmoid series of chambers has each succeeding chamber added in a clockwise direction, each of the two series of chambers is directed contraclockwisely, as is shown by the figure.

The question is whether or not the direction of the spiral, quinqueloculine or sigmoid arrangement is fixed in the species. As far as we have examined a great number of specimens of various species, it is fixed in some species, especially those species of more advanced genera, such as *Sigmomorphina*, *Sigmoidella*, and *Polymorphina*.

FISTULOSE OUTGROWTHS

One of the most interesting peculiarities of the Polymorphinidae is the development of irregular fistulose outgrowths, generally covering the upper part of the test and often extending over the whole surface. It is interesting to note that the fistulose tubes are often rugose, as is the wall of an extra small chamber. The fistulose forms have been treated by some writers as constituting collectively a distinct species or even generic group. *Raphanulina*, *Apiopterina*, and *Aulostomella* are generic names given to fistulose forms. Brady, Parker, and Jones, in their monograph of the genus *Polymorphina*, unite all fistulose forms and put them in *Polymorphina orbignii* (Zborzewski), but much later H. B. Brady found that almost all the common species of the Polymorphinidae have fistulose varieties, and expressed the opinion that it appears more natural to assign fistulose modifications to their respective types, and their true position is that of individuals of monstrous development. We are of the same opinion as Brady on these problems, and in the present paper fistulose forms are not separated even as a variety.

The trouble is with the identification of the fistulose specimens, because important characters of the species are often concealed beneath the fistulose outgrowths. Many authors have figured and named fistulose forms, and in most cases the fistulose part is carefully drawn, while the body of the test itself is neglected. Therefore it is very difficult to determine to what species the figured fistulose form is related.

For example, *Raphanulina humboldti* has well-developed fistulose outgrowths, but it is impossible to determine the arrangement of chambers. Therefore we are compelled to abandon it as a species, although it is described as early as 1834. Many varietal and specific names given to the fistulose forms are omitted in the present paper because of the difficulty in specifically determining them.

ATTACHED FORMS

Attached forms are not common in the family. Most attached forms are compressed, and the main body of the test resembles some

particular species. However, in this paper, attached forms are separated from the others.

ORNAMENTATION OF WALL

Many species in the family have ornamented varieties. Ornamented forms are separated as a variety of smooth forms having the same characters. When an ornamented form is described earlier than a smooth form, the smooth form is taken as a variety.

PHYLOGENETIC RELATION OF THE GENERA OF THE POLYMORPHINIDAE

The closeness of the relationship between the Polymorphinidae and the Lagenidae is very marked. The wall is similar and especially the terminal radiate aperture. However, the arrangement of chambers is very different from anything seen in the Lagenidae. It is spiral, triloculine, quinqueloculine, or sigmoidal, and in some advanced groups it becomes biserial or uniserial. The most important problem to make clear is how the spiral arrangement of chambers is derived and what the relationship is between various genera with different arrangements of chambers. That is the phylogenetic problem of the Polymorphinidae.

In order to study the phylogenetic relations of various genera of the Polymorphinidae, the detailed examination of the arrangement of chambers of any species is of utmost importance as in other groups of the foraminifera. Excepting d'Orbigny, who gives end views of his earliest species of the family in his Tableaux Methodique, no one has figured end views showing an arrangement of chambers of any species of the Polymorphinidae.

This circumstance caused great difficulties in identification. Some authors considered that the arrangement of chambers of *Guttulina* is irregular or triserial, but we have examined very many species of *Guttulina* and have not seen a single specimen having either an irregular or triserial arrangement of chambers. We are convinced that the arrangement of chambers in the Polymorphinidae is very regular and that the family can be divided into several genera according to the various arrangements of chambers as in other families of Foraminifera.

In order to discuss the relationships of various arrangements of chambers, it is of interest to study some typical species of various groups according to their geologic distribution. The geologically oldest species of the Polymorphinidae hitherto recorded are *Polymorphina avia* and *P. abavia*, both described by Ehrenberg from the Ordovician of the neighborhood of Leningrad. These two species are aggregations of glauconite, and there are some doubts about their organic origin.

Chapman described two species of *Polymorphina*, *P. seminis*, and *P. archaica* from the Middle Devonian of Eifel in Germany. They resemble *Globulina* in their general outline. From the phylogenetic consideration of the family, we doubt if they be true *Globulina*. No other authors have noted the occurrence of the Polymorphinidae in the Paleozoic rocks.

In the Mesozoic the Polymorphinidae became gradually frequent although most Triassic species are doubtful. *Guttulina (?) raibliana*, described by Gümbel from the Upper Triassic of Austria, judged from the figure, surely belongs to the Polymorphinidae. It resembles *Guttulina*, but the chambers seem to be arranged in a spiral series, as in many of the more primitive Jurassic species.

With the beginning of the Jurassic the Polymorphinidae are of rather frequent occurrence, and more than 50 species are recorded from various Jurassic deposits in Europe. Some of them are identified with Tertiary or Recent species, such as *P. burdigalensis*, *P. compressa* etc., but most of them are known only from the Jurassic. Terquem described most of the Jurassic species from the Oolite and the Lias in France. These Jurassic species are very important for a study of the earlier forms of the Polymorphinidae and its relationships with the Lagenidae. Terquem's figures are probably not drawn well, and no end view showing the arrangement of chambers is given. Ozawa tried to examine Terquem's original specimens in Paris, but it was almost impossible because they are not in good order. Therefore the following discussion of the arrangement of chambers of Jurassic species is according to Terquem's figures with the aid obtained from a study of our Jurassic specimens found in England.

Among Terquem's species, *Polymorphina bilocularis* is a two-chambered fusiform species and is very similar to *Vaginulina*, but the second chamber more or less deviates from the coiled position of *Vaginulina*, and is in a spiral position.

Schwager's *Globulina secale* (1865), in its external appearance, is almost identical with *P. bilocularis* (1864), but it has numerous chambers, most of which are entirely embraced by the last two chambers and are not visible from the exterior. From Schwager's description and figures alone it is almost impossible to determine whether or not the species really belongs to the Polymorphinidae.

Polymorphina intorta Terquem, *P. nitidiuscula* Terquem, and *P. obliqua* Terquem, judging from their figures, may represent intermediate stages between coiled *Vaginulina* and spiral Polymorphinidae. Their successive chambers are added in planes less than 90° apart from one another. *P. sacculus* Terquem is a rather interesting species, having three chambers, arranged evidently in a spiral series. Terquem's species *Polymorphina triloba*, *P. breoni*, *P. polygona*, *P. ovula*, and *P. avena* have more than two chambers arranged

in a spiral series, and each succeeding chamber is removed very much farther from the base. Among them, *P. polygona* is the most interesting, and Terquem put several forms with very different appearances in this species, some three chambered and compressed, the others with an early stage similar to *P. sacculus*. We have a specimen from the Kimmeridge clay in England which is very similar to Terquem's first and second figures of *P. polygona*, and we have identified it with Terquem's species; and it is described in the present paper. In a certain position in side view the specimen is very much like an elongated *Guttulina*, but the chambers are arranged in a spiral series instead of a quinqueloculine one.

Terquem's species *Polymorphina distincta*, *P. amygdala*, and *P. pyriformis* are very similar to *P. polygona* in their arrangement of chambers.

From such spiral species are derived elongated forms such as *P. mutabilis* (*immutabilis*) Schwager, *P. pyriformis* Terquem, *P. pupiformis* Terquem, *P. ovigera* Terquem, *P. quadrata* Terquem, and *P. distincta* Terquem. In these species chambers are arranged in a spiral, and each succeeding chamber is removed much farther from the base, giving to the test an appearance of having a somewhat uniserial or biserial arrangement of chambers.

In such species as *Polymorphina cruciata* Terquem, *P. lagenalis* Terquem, and probably *P. squammata* Terquem, and *P. angustata* Terquem, the chambers are added in planes 90° apart from one another, and accordingly they are tetraserial. *P. irregularis* Terquem may represent an intermediate form between such tetraserial forms and the spiral species above referred to. Two such tetraserial forms are reported by Chapman from the Lower Greensand in England (Littleton, Bargate Bed of Surrey). They are *Polymorphina rhabdogonioides* and *P. frondicularioides*, both of which are figured on Plate 1 of this paper. Chapman added in the description that he thinks that they may represent a new genus or subgenus.

Polymorphina imbricata Terquem is a cylindrical form with chambers seemingly arranged in a biserial series, but we doubt if it is a truly biserial species.

One of the most important groups among the Jurassic Polymorphinidae is that having globular or fusiform species with the sutures not depressed and chambers arranged in a nearly triserial spiral series. In this group are included *Polymorphina liassica* Strickland, *P. fontinensis* Terquem, *Globulina laevis* Schwager, *Guttulina similis* Terquem and Berthelin, and several others. The globular species such as *P. fontinensis* and *Guttulina similis* are few chambered forms, and in their general outline they are very similar to Cretaceous and Tertiary Globulinas such as *Globulina lacrima* and *G. gibba*. But if we examine in detail figures of Jurassic globular forms, we can easily

recognize the striking difference in arrangement of chambers between Jurassic globular Polymorphinidae and Cretaceous and Tertiary *Globulina*. For example, we may note *Globulina laevis* Schwager from the Lower Oxfordian [3] and *Polymorphina gibbosa* Terquem from the Fuller's Earth. They are oval forms, having a few chambers which are arranged in a quite different series from the arrangement of chambers in *Globulina gibba*. In both species each succeeding chamber apparently becomes smaller and smaller, and the chambers are arranged in a spiral series. Such globular, spiral forms are evidently derived from other primitive Jurassic spiral forms by having more overlapping and somewhat regularly triserial chambers.

The fusiform *P. liassica* is also similar to species of Cretaceous and Tertiary fusiform Globulinas such as *Globulina prisca* and *G. minuta* in its general outline, and it is apparently impossible to separate them. However, it may be considered that there are probably some globular or fusiform Polymorphinidae in the Jurassic and Cretaceous derived directly from the primitive spiral group.

There is only one species of the Polymorphinidae described from the Jurassic which may be placed under *Guttulina* with some doubt. That is an ovate, somewhat compressed *Polymorphina pygmaea* Schwager reported from the lower Oxfordian in Germany. It is quite different from any of the other hitherto known Jurassic species and somewhat resembles *Guttulina lactea*, but the chambers are arranged in a clockwise series. The biserial species appear also to be rare. Excepting for very doubtful *P. imbricata*, already noted, *Polymorphina sinuata* Terquem is the only species having a compressed test and biserial chambers. It evidently differs from more advanced biserial *Pseudopolymorphina* and *Polymorphina* which are derived from *Guttulina* and *Sigmomorphina*, respectively. It may be derived directly from some Jurassic spiral group. Some Cretaceous biserial species such as *Polymorphina pleurostomelloides* and *P. gaultina* are undoubtedly related to Jurassic biserial forms.

There are some ambiguous species described from the Jurassic, such as *P. annulata*, *P. oviformis*, and *P. septata*, etc. They are either doubtful Polymorphinidae or abnormal species. Spiral and tetraloculine Polymorphinidae seem to have disappeared in the Lower Cretaceous. We have a spiral species from the Gault in England which is new. The two tetraloculine species described by Chapman are also from England.

These primitive Polymorphinidae are replaced by the more advanced *Guttulina*, which becomes rather common in both Lower and Upper Cretaceous, as do *Pyrulina* and *Globulina* as well. *Guttulina* having the elongate quinqueloculine arrangement of chambers may

[3] Jahresh. Ver. vat. Nat. Württ., vol. 21, 1865, pl. 7, fig. 7.

be taken as an original stock from which various Tertiary and Recent specialized genera having different arrangements of chambers arose.

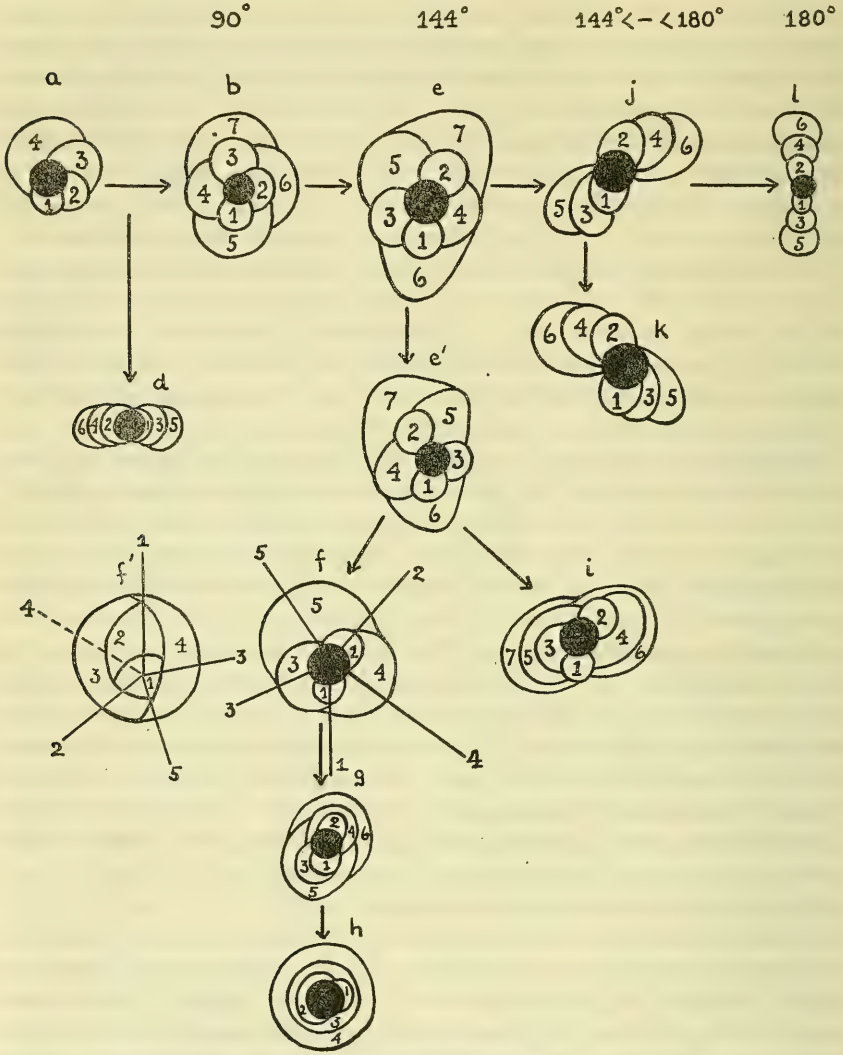


FIGURE 1.—IDEALIZED BASAL VIEWS OF VARIOUS GENERA OF THE POLYMORPHINIDAE TO SHOW THE ARRANGEMENT OF CHAMBERS. *a*. EOGUTTULINA (SPIRAL). *b*. QUADRULINA (TETRALOCULINE). *d*. PALEOPOLYMORPHINA (SPIRAL-BISERIAL). *e*, *e′*. GUTTULINA; *e*, CLOCKWISE QUINQUELOCULINE; *e′*, CONTRACLOCKWISE QUINQUELOCULINE. *f*, *f′*. GLOBULINA; *f*, MICROSPHERIC FORM; *f′*, MEGALOSPHERIC FORM. *g*. PYRULINA (QUINQUELOCULINE-BISERIAL). *h*. GLANDULINA (BISERIAL-UNISERIAL). *i*. PSEUDOPOLYMORPHINA (QUINQUELOCULINE-BISERIAL). *j*, *k*. SIGMOMORPHINA, SIGMOIDELLA (SIGMOIDAL); *j*, CLOCKWISE; *k*, CONTRACLOCKWISE. *l*. POLYMORPHINA (BISERIAL)

Guttulina is characterized by a quinqueloculine arrangement of chambers, and each succeeding chamber is added upwardly, so that all apertures are directed toward one end. Its chambers are added in planes 144° apart from one another.

Globulina has apparently triserial chambers. However, the actual arrangement is not triserial but somewhat quinqueloculine. The apparent triserial series of chambers has resulted from much overlapping of the chambers as shown by the text figures.

Pyrulina is an elongate or fusiform genus, in which the chambers are typically quinqueloculine in the early stage, later becoming biserial. As is already noted, it is very difficult to separate some Tertiary and Recent species of *Globulina* and *Pyrulina* from some Jurassic globular or fusiform species because of their homeomorphy or parallel evolution.

Pyrulina and *Globulina* are abundant in the Upper Cretaceous, Eocene, Oligocene, and Miocene. In the Pliocene and Recent, they are of rather rare occurrence compared with other genera.

Glandulina, as far as its genotype species *Glandulina laevigata* is concerned, is closely related to *Pyrulina* and should be included in the Polymorphinidae. The microspheric form of *Glandulina laevigata* has the early chambers invariably arranged in a biserial series, although in the later stage and also in the megalospheric form the septa are almost horizontal and parallel.

In the Upper Cretaceous *Pseudopolymorphina* is introduced. It has a test with the early chambers arranged in a quinqueloculine series, while the later ones become biserial and the chambers are slightly overlapping.

Much more advanced genera such as *Sigmomorphina*, *Sigmoidella*, and *Polymorphina* appear for the first time with the beginning of the Tertiary. *Sigmoidina* is a group having a quinqueloculine arrangement of chambers as in *Guttulina*, but each succeeding chamber extends down to the base and embraces the earlier ones, so that but a few chambers are visible from the exterior.

Sigmoidella is undoubtedly related to *Sigmoidina*, and the chambers are involute, but they are arranged in an open sigmoid series.

Sigmomorphina arose from *Guttulina* s. str. by developing elongated chambers added laterally in a sigmoid series. In some elongated *Sigmomorphina* each succeeding chamber in the later stage is removed much farther from the base. *Sigmomorpha*, the genotype species of which is *S. sadoensis*, is included in *Guttulina*, after the detailed examination of numerous species, although some specimens show a more or less sigmoid arrangement of chambers.

Polymorphina is the most advanced and specialized genus. The primitive forms have a sigmoid arrangement of chambers in their early stages, but the advanced species are entirely biserial, and each succeeding chamber is farther removed from the base.

Dimorphina tuberosa seems to us to be a very doubtful species. Ozawa found that the original specimen has been lost, and the figures

of the species given by Fornasini are evidently a *Marginulina*.[4] Two species of *Dimorphina* described from the Vienna Basin by d'Orbigny are also *Marginulina* with coiled chambers in their early stage.

Therefore *Dimorphina* is a very uncertain genus. We have a few specimens having the early chambers arranged in a quinqueloculine or somewhat triloculine series, later becoming uniserial. Such forms correspond somewhat with the supposed *Dimorphina*, but provisionally we have included them in *Pseudopolymorphina*, from which they are undoubtedly derived by adding chambers in a uniserial arrangement.

Dimorphina compacta described by H. B. Brady, Parker, and Jones from the Crag of Sutton is an arcuate species resembling *Marginulina*. It does not belong to the Polymorphinidae.

In the following is summarized the evolution of the Polymorphinidae from the standpoint of the changes in arrangement of the chambers.

1. Some doubtful species of the Polymorphinidae are recorded from the Palaeozoic as far back as the Ordovician, but undisputed species belonging to the family are known only from the Triassic and later formations.

2. The Polymorphinidae are undoubtedly derived from some coiled form of the Lagenidae such as *Marginulina* or *Vaginulina* by introducing a spiral arrangement of chambers. The family may be divided into the following groups based on the differences in the arrangement of the chambers:

a. Chambers arranged in a spiral series added in planes less than 90° apart from one another, each succeeding chamber removed farther from the base.

Eoguttulina.

This group is the most primitive among the Polymorphinidae and is known from the Triassic, Jurassic, and Lower Cretaceous of Europe. Provisionally we include in the group those forms having the spiral chambers added in planes more than 90° but less than 144° apart from one another.

b. Chambers added in planes 90° apart from one another, that is, arranged in a tetraloculine series at least in the later stage.....**Quadrulina.**

This group is also known only from the Jurassic and Lower Cretaceous of Europe.

c. Chambers added in planes 120° apart from one another, that is, arranged in a spirally triloculine series. Chambers more or less overlapping, giving the test a globular or fusiform appearance. This group should be studied in detail. At present we include the group in *Eoguttulina* because of its spiral arrangement of chambers.

d. Test with the early chambers spiral, later ones becoming biserial.

Paleopolymorphina.

e. Chambers more or less elongated, added in planes 144° apart from one another, that is, the chambers arranged in a quinqueloculine series. This group is subdivided into two divisions—one, *Guttulina* s. str. in which each succeeding chamber is removed farther from the base; the other, *Sigmoidina*, in which normally each succeeding chamber entirely embraces the earlier ones of its series.

[4] Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 8, 1900, p. 35, fig. 39.

A quinqueloculine arrangement of chambers seems to be rather stable in the family, as *Guttulina* is known from the Jurassic (?) and is rather common in the Cretaceous, especially in the Upper Cretaceous, and very abundant in various Tertiary deposits as well as Recent forms throughout the world.

f. Chambers, in the early stage of the microspheric form, arranged in a quinqueloculine series, later much overlapping, becoming apparently triserial, that is, chambers added in planes more than 144° and less than 180° apart from one another ..... **Globulina.**

g. Chambers invariably more or less elongated and embracing, arranged at first in a somewhat quinqueloculine series, later becoming biserial ..... **Pyrulina.**

h. Early chambers added in a quinqueloculine or biserial manner, later ones becoming uniserial ..... **Glandulina.**

This group is of rather rare occurrence in the older Tertiary, but common from the Miocene to the Recent.

i. Early chambers in a quinqueloculine series, later each succeeding chamber farther removed from the base, becoming biserial and in some cases uniserial. **Pseudopolymorphina.**

The supposed *Dimorphina* is provisionally included in the present group.

Pseudopolymorphina occurs in the Cretaceous, but not as commonly as in the Tertiary and Recent.

j. Test at least in the adult with the chambers added in planes slightly less than 180° and more than 144° apart from one another, each succeeding chamber farther removed from the base ..... **Sigmomorphina.**

This group is derived from *Guttulina* and is known only from the Tertiary and Recent.

k. Chambers arranged as those of the preceding group, but each succeeding chamber embracing the earlier ones of its series. It is derived from *Sigmoidina* and is known from the Tertiary as well as Recent ..... **Sigmoidella.**

l. Test with the early chambers arranged in a sigmoid series becoming biserial or entirely biserial from the start. This is the most advanced group among the Polymorphinidae and the chambers are added in planes 180° apart from one another. It is only known from the Tertiary and Recent. It must be kept in mind that even though it may be made up of an entirely biserial series of chambers the test has an appearance of a slightly sigmoid arrangement of the chambers continuing the shape of its ancestral development ..... **Polymorphina.**

BRIEF NOTES ON VARIOUS GENERIC NAMES GIVEN TO THE POLYMORPHINIDAE

There are not so many generic names given to various groups of the Polymorphinidae. De Montfort's three genera, *Arethusa*, *Misilus*, and *Cantharus*, are so very rough and ill drawn that they are recognized with difficulty as belonging to the Polymorphinidae, notwithstanding evidence of their having been copied from Soldani's plates. *Arethusa* is given to the figure copied from Soldani's figure *n n* (misprinted L L by de Montfort) in Plate 107, and *Misilus* is considered by Parker and Jones to be used for a globular fistulose form. While *Cantharus* (seventy-fifth genus) is a very inaccurate copy of Soldani (Testaceogr. pl. 107, fig. *r r*, misprinted *p p* by de Montfort), Parker and Jones compared Soldani's figure with '*Polymorphina lactea.*'

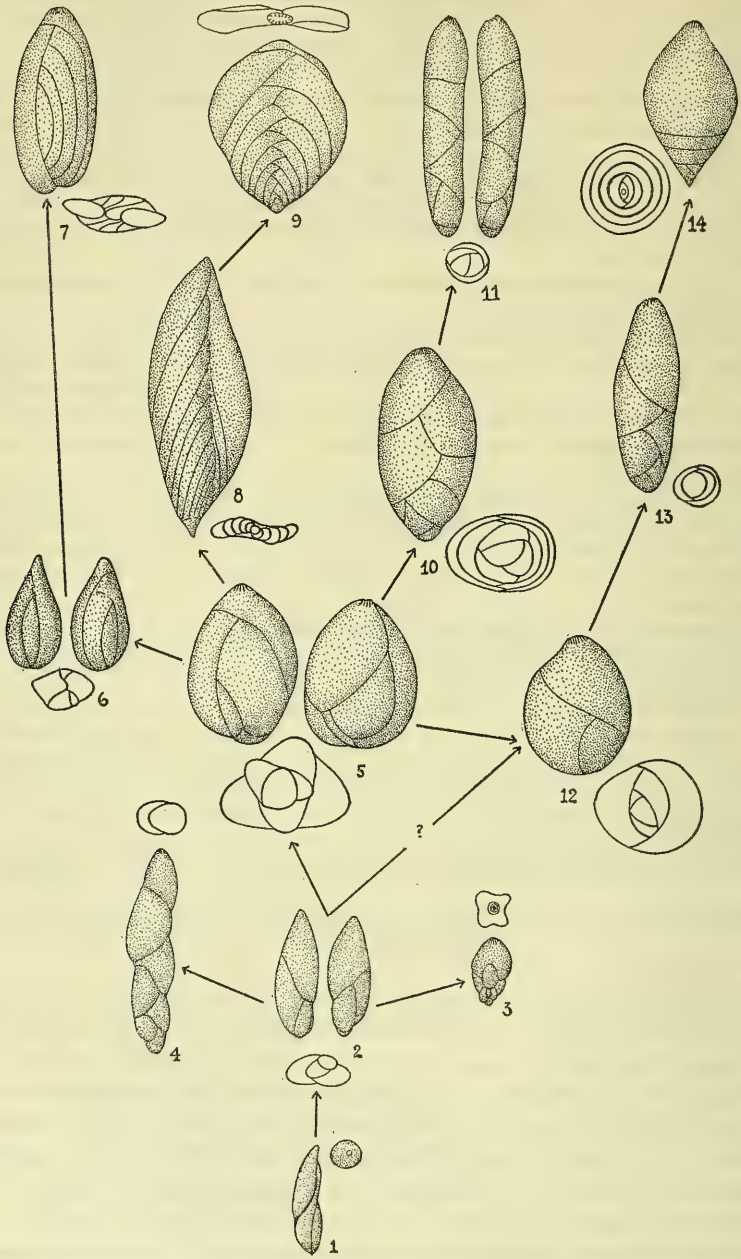


FIGURE 2.—DEVELOPMENT AND RELATIONSHIPS OF THE GENERA OF THE POLYMORPHINIDAE. 1, 2. EOGUTTULINA. 3. QUADRULINA. 4. PALEOPOLYMORPHINA. 5. GUTTULINA. 6, 7. SIGMOIDELLA. 8. SIGMOMORPHINA. 9. POLYMORPHINA. 10, 11. PSEUDOPOLYMORPHINA. 12. GLOBULINA. 13. PYRULINA. 14. GLANDULINA

Arethusa was used by Fleming, Bowditch, and Thorpe, but the other two genera were abandoned for a long time. At present no one uses any of Montfort's three generic names because of their poor and rough illustrations. To the fistulose forms three different generic names were given. Those are Zborzewski's *Raphanulina* and *Apiopterina* and Alth's *Aulostomella*, which are included in *Globulina*, as far as the species under those genera are concerned.

Psecadium is said to have been used by Reuss in manuscript, but it was used for the first time by Neugeboren in 1856. Its first species, *P. simplex*, is a *Marginulina*. Reuss's *Psecadium acuminatum* given to Schlicht's figures [5] undoubtedly belongs to the Polymorphinidae and is considered by us as a synonym of *Glandulina*.

Von Schlicht's *Rostrolina* is considered by Brady, Parker, and Jones to be placed under *Polymorphina*, but as is already discussed by Silvestri, most of its species belong to the Ellipsoidinidae, and the first species of *Rostrolina*, according to A. Silvestri, is *Ellipsopleurostomella rostrata*. The first species of *Atractolina* is named by Reuss *Psecadium acuminatum*.

Pyrulinella is given to a fusiform group having a biserial stage, but its genotype species, *Polymorphina lanceolata* Reuss, very doubtfully belongs to the Polymorphinidae, and it resembles *Virgulina*, and accordingly the name is dropped and the fusiform group having a biserial stage is placed under *Pyrulina*.

Dimorphina is an ambiguous genus, although it has been used since d'Orbigny established it. D'Orbigny's species, *Dimorphina tuberosa*, considered from Fornasini's figure, is a *Marginulina*. Most species hitherto described under *Dimorphina* can be placed in other genera.

SPECIES DESCRIBED AS BELONGING TO THE POLYMORPHINIDAE BUT NOT ACTUALLY POLYMORPHINIDAE

There are many species which are described under the Polymorphinidae but actually do not belong to the family. D'Orbigny's *Polymorphina acuta* and *P. digitalis*, both described from the Vienna Basin, have been recognized by later authors as good species but they are *Virgulina* (original and paratype specimens examined by Ozawa). Reuss's *P. lanceolata* is used often by later authors, but the first figured specimen appears to belong to *Virgulina*.

Costa from 1856 to 1864 described fifteen species of the Polymorphinidae. There are two under *Polymorphina*, seven under *Guttulina*, five under *Globulina*, and one under *Aulostomella*. His *Polymorphina* is *Virgulina*, his *Guttulina* and *Globulina* are mostly *Bulimina*,

[5] Foram. Septar. Pietzpuhl, 1870, pl. 25, figs. 1–10.

and one *Aulostomella* (*A. dorsigera*) appears to belong to the Polymorphinidae.

Ehrenberg described very many species of *Polymorphina* which were examined by us at the Museum of Natural History in Berlin, but most of them are mounted in Canada Balsam, and it is very difficult to determine them. Ehrenberg placed under *Polymorphina* various biserial forms such as *Virgulina* and *Bolivina*, but there are none of his species which can be considered with confidence to belong to the Polymorphinidae. Therefore we omitted his species.

Miller's three species of *Polymorphina* are apparently glauconitic nodules with cracks and not recognizable. *Polymorphina complexa* Sidebottom from the Kerimba Archipelago has the same arrangement of chambers as *Guttulina*, but it has pores along the suture lines, and the aperture is quite different from any genus of the family. It may be a new genus belonging to some other family.

Silvestri described one new species and two new varieties from the Pliocene at Coroncina. His *Polymorphina pliocaena* and its variety *tricostata* are evidently young specimens of *Robulus*. *P. oblonga* var. *fistulosa* is a fistulose *Guttulina*.

There are still many doubtful species of the family which are not treated in the present paper: as, d'Orbigny's *Polymorphina irregularis* (1839), *P. rochefortiana*, and many others.

Genus EOGUTTULINA Cushman and Ozawa, new genus

Test with the chambers arranged in a spiral series added in planes less than 90° apart from one another, each succeeding chamber removed farther from the base.

Genotype.—Eoguttulina Anglica.

EOGUTTULINA ANGLICA Cushman and Ozawa, new species

Plate 1, figures 3 *a–c*

Test elongated, more or less cylindrical, the greatest breadth in the upper half, obtuse at the base, acuminate toward the apertural end; chambers somewhat longer than broad, inflated, not much embracing, arranged in a spiral series, each succeeding chamber much farther removed from the base; sutures depressed, distinct; wall smooth; aperture radiate.

Length 0.65 mm.; breadth 0.28 mm.

Holotype.—(Cushman Coll. No. 10990.) From Cretaceous, Cambridge Greensand, Saxon Cement Works, Cambridge, England.

In a certain position in side view, *Eoguttulina anglica* resembles some elongated forms of *Guttulina*. Each succeeding chamber is removed farther from the base, as in an elongated *Guttulina*, but the chambers are arranged in a spiral series and not quinqueloculine.

EOGUTTULINA LIASSICA (Strickland)

Plate 1, figures 2 *a–c*

Polymorphina liassica STRICKLAND, Quart. Journ. Geol. Soc., vol. 2, 1846, p. 30, fig. *b* (in text).

Polymorphina metensis TERQUEM, Quatr. Mem. Foram. Lias, 1864, p. 301, pl. 13, figs. 38*a,b*.—TERQUEM and BERTHELIN, Mém. Soc. Géol. France, sér. 2, vol. 10, pt. 3, 1875, p. 68, pl. 6, figs. 1*a–j*.

Globulina laevis SCHWAGER, Wurttemberg, Naturwiss. Jahreshefte, vol. 21, 1865, p. 137, pl. 7, figs. 5, 25.

Test elongated fusiform; chambers few, elongated, embracing, arranged in a triserially spiral series, each succeeding chamber removed farther from the base; sutures not depressed, distinct; wall smooth; aperture radiate.

Length 0.35 mm.; breadth 0.15 mm.

The present species was described by Strickland from the Liassic formation at Wainlode Cliff, Gloucestershire, England. We have a single specimen from the Liassic in Gloucestershire which is very similar to Strickland's species in general aspect. The only difference is that our specimen is slightly more slender.

In general outline it is very similar to the Cretaceous *Globulina prisca*, and it is almost impossible to separate them at a glance. The arrangement of chambers is seemingly different, that of the present species being spiral from the first chamber, while in that of *Globulina prisca* the first chambers are completely surrounded by the following ones. This may be a primitive form of an elongated *Globulina*, but for the present, we prefer to place it in *Eoguttulina*.

Polymorphina metensis described by Terquem from the Middle Lias of Saint-Julien-les-Metz and also by him with Berthelin from the Lower Lias of d'Essey-les-Nancy seems to be very close to the present species, although its chambers are much more embracing.

Globulina laevis from the Jurassic in Germany has a small (0.3 mm. in length) fusiform, slightly compressed test, and in its general features it is very similar to the present species.

Polymorphina oolithica from the Jurassic of Conflans and Fontenoy resembles the present species in general outline, but it is compressed. It may be different from the present species.

Distribution.—All the records of this species are from the Jurassic.

EOGUTTULINA POLYGONA (Terquem)

Plate 1, figures 1 *a–c*

Polymorphina polygona TERQUEM, Quatr. Mém. Foram. Lias, 1864, p. 305, pl. 14, figs. 16–20, 21–41(?).

Test somewhat compressed, elongated, acute toward the apertural end; chambers longer than wide, more or less triangularly compressed, arranged in a spiral series, each succeeding chamber farther removed

from the base; sutures depressed, rather distinct; wall smooth; aperture radiate.

Length 0.33 mm.; breadth 0.12 mm.

We have one specimen from the Kimmeridge Clay in England which is very similar to Terquem's figures of few chambered specimens.

Terquem's Figures 16–20 appear to be very similar and may be included in the present species, but as to the others, it is doubtful whether or not they are the same as the present species.

Distribution.—Terquem reported it from the lower Lias at Beauveau and Auline in France.

Genus QUADRULINA Cushman and Ozawa, new genus

Test with the chambers added in planes 90° apart from one another, that is, arranged in a tetraloculine series, at least in the later stage.

Genotype.—Quadrulina rhabdogonioides.

QUADRULINA RHABDOGONIOIDES (Chapman)

Plate 1, figures 4 *a*, *b*

Polymorphina rhabdogonioides CHAPMAN, Quart. Journ. Geol. Soc., vol. 50, 1894, p. 716, pl. 34, figs. 12 *a*, *b*.

"Test subpyramidal and quadrifacial; bluntly pointed at the base and rapidly increasing in width toward the oral extremity. The test is smooth and consists of a Polymorphine series of chambers (slightly twisted as regards the commencement), the margins of which are deeply sunken, and the chambers themselves, numbering about five to seven on each face of the test, well inflated, especially in the case of the more or less central one visible on each face. The terminal chamber is large and embracing, subquadrangular in section, but not regular. The aperture is circular and with margin pectinate.

"Length one-seventieth inch (0.36 mm.); width diagonally one one hundred and tenth inch (0.23 mm.).

"The foregoing species is probably a dimorphous form, combining *Polymorphina* with *Rhabdogonium*, and in the event of other varieties becoming known it may be found necessary to form a distinct genus for this type.

"Two specimens from the pebble beds, Littleton, Bargate Bed of Surrey (lower greensand)."

We have no specimen of this species. The above is quoted directly from Chapman, and the figures are copied from his plate.

From Chapman's figures and description the present species seems to have the chambers arranged in a spiral series in the early stages, later becoming tetraserial.

QUADRULINA FRONDICULARIOIDES (Chapman)

Plate 1, figures 5 *a*, *b*

Polymorphina frondicularioides CHAPMAN, Quart. Journ. Geol. Soc., vol. 50, 1894, p. 716, pl. 34, figs. 13 *a*, *b*.

"Test subpyriform, but somewhat compressed, tapering more acutely towards the aboral extremity; test rhomboidal in section, surface smooth, and swollen along the centre of each face. About six chambers are visible on each surface, slightly inflated, and bordered by well marked sutures. The last chamber is pinched up towards the apex; but it embraces the whole width of the test, after the manner of *Frondicularia* and *Lingulina*. Aperture slightly elongate, with a stellate border. Length one sixty-sixth inch (0.37 mm.), width one one-hundred-and-thirtieth inch (0.19 mm.).

"This form also appears to represent a new genus or subgenus, combining two hitherto distinct generic types.

"One specimen from the pebble bed, Littleton."

We have no specimen of the present species.

The above is quoted directly from Chapman, and the figures are copied from his plate.

QUADRULINA LAGENALIS (Terquem)

Plate 1, figures 6 *a*, *b*

Polymorphina lagenalis TERQUEM, Quatr. Mém. Foram. Lias, 1864, p. 301, pl. 13, figs. 39*a*, *b*.

Terquem's description of the species runs as follows:

P. testa laevigata, elongata, ovata, rotundata, postice obtusa, antice succisa, lateribus aequali, loculis septem alanis, quatuor induplice cruce dispositis, uno in medio quadrangulari, apertura magna, long. 0.58 mm.

Locality: Quenleu-les-Metz, lower Lias.

This is a distinctive species having a tetraloculine arrangement of chambers and is here copied in order to show a Jurassic example of the genus.

Terquem's figures are not sufficient to show completely the tetraloculine arrangement of chambers.

Genus GUTTULINA d'Orbigny, 1826

GUTTULINA PROBLEMA d'Orbigny

Plate 2, figures 1–6; Plate 3, figures 1 *a–c*

Guttulina problema d'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 14.—CUSHMAN and SCHENCK, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 310, pl. 43, figs. 9–11.

Polymorphina problema d'ORBIGNY, Modèles, 1826, No. 61.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 568, pl. 72, fig. 20; pl. 73, fig. 1.—JONES, Foram. Crag, pt. 3, 1896, p. 267, pl. 1, fig. 64; pl. 5, fig. 23; pl. 6, figs. 12 *a*, *b*.—BURROWS and HOLLAND, Proc. Geol. Assoc.,

vol. 15, 1897, p. 46, pl. 2, fig. 17.—Weller, Geol. Surv. New Jersey, Paleontology, vol. 4, 1907, p. 253, pl. 3, figs. 27, 28.—Cushman, Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 264, pl. 54, figs. 3, 4; U. S. Geol. Survey Prof. Paper 133, 1923, p. 33, pl. 5, fig. 6.—Chapman, New Zealand Geol. Survey, Pal. Bull. No. 11, 1926, p. 68, pl. 5, figs. 10–12.

Polymorphina (*Guttulina*) *problema* Andreae, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, pt. 3, 1884, p. 118, pl. 9, fig. 21 *a–c*.

Polymorphina problema var. Hosius, Ver. Nat. Hist. Vereins Pr. Rheinlande, vol. 50, 1893, p. 103, pl. 2, figs. 2 *a–c* (not figs. 3–5).

Guttulina communis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 15, pl. 12, figs. 1–4, Modèles No. 62.—Reuss in Geinitz, Grundr. Verstein., 1845–46, p. 669, pl. 24, fig. 82.

Polymorphina communis Roemer, Neues Jahrb. f. Min., etc., 1838, p. 385, fig. 29.—H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1869, p. 224, pl. 39, figs. 10 *a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 568, pl. 72, fig. 19.—Flint, U. S. Nat. Mus. Rept., 1897, p. 319, pl. 67, fig. 6 (part).—Bagg, Bull. 88, U. S. Geol. Survey, 1898, p. 60, pl. 6, fig. 2.—Fornasini, Mem. Accad. Sci. Istit., Bologna, ser. 5, vol. 8, 1900, p. 33, fig. 37.—Weller, Geol. Survey New Jersey, Paleontology, vol. 4, 1907, p. 248, pl. 3, fig. 18.—Bagg, U. S. Geol. Survey, Bull. 513, 1912, p. 68, pl. 21, figs. 7 *a*, *b*, 13–15.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 87, pl. 37, fig. 7.

Polymorphina lactea Walker and Jacob var. *communis* Williamson, Recent Foram. Great Britain, 1858, p. 72, pl. 6, figs. 153–155.

Polymorphina (*Guttulina*) *lata* Egger, Neues Jahrb. für Min., Jahrg. 1857, p. 288, pl. 13, figs. 22–24.

Guttulina cretacea Alth, Haidinger's Nat. Abhandl., vol. 3, 1850, p. 262, pl. 13, fig. 14.—Reuss, Haidinger's Nat. Abhandl., vol. 4, 1851, p. 28, pl. 4, fig. 10.

Polymorphina cretacea Egger, Abhandl. Kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 127, pl. 17, figs. 12, 13.

Globulina irregularis Terquem, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 44, pl. 4 (9), figs. 13, 14.

Polymorphina lactea Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 5, No. 9, 1907, p. 9, pl. 2, fig. 11.—Franke, Abhandl, geol. pal. Instit. Univ. Greifswald, vol. 6, 1925, p. 77, pl. 6, fig. 18; Danmarks Geol. Unders. 2, Raekke, No. 46, 1927, p. 34, pl. 3, fig. 13.

Globulina gibba var. *glomula* Fornasini, Mem. Accad. Istit. Bologna Sci., ser. 5, vol. 9, 1900–1902 (1902), p. 68, fig. 20 in text.

Test broadly fusiform, acute at the apertural end, more or less rounded at the initial end in the megalospheric form, rather rounded at the base in the microspheric form; chambers elongated, more or less inflated, arranged in a clockwise, quinqueloculine series, each succeeding chamber slightly removed from the base; sutures depressed, very distinct; wall rather thick, smooth; aperture radiate.

Length, 0.50–1.25 mm.; breadth, 0.40–1.25 mm.; thickness, 0.28–0.70 mm.

Most authors describe *Guttulina problema* as a species having chambers arranged triserially or crowded together irregularly, but we have seen no specimens having triserial or irregularly arranged chambers, and all the specimens are characterized by a quinquelocu-

line arrangement of chambers. Brady, Parker, and Jones give a figure drawn from d'Orbigny's model No. 61 (pl. 39, fig. 71*a*), but so far as our model shows, the figure is not well drawn and does not represent the species correctly. The trouble is that d'Orbigny's *Guttulina problema,* figured from the Vienna Basin, so far as his original specimen examined by Ozawa is concerned, is different from his original represented by the model. Moreover the model, judging from ours, seems not to be made well.

That is, the arrangement of chambers shown by the model appears at first to be in a very roughly clockwise quinqueloculine series, and the third chamber is added abnormally. D'Orbigny's original specimen is lost; therefore the model is the only reference having any authority. It may be supposed that d'Orbigny's original of *Guttulina problema* was an abnormal specimen.

We have examined some Pliocene material from Castel Arquato, which is the original locality of d'Orbigny's *Guttulina problema,* and obtained some specimens which are very close to d'Orbigny's model, but there is no abnormal specimen just like the model. One of our specimens is figured. The figured specimen, as well as the others from the same locality, more or less resemble *Guttulina communis* figured by d'Orbigny in 1826, the differences are that *Guttulina problema* has one more chamber than the latter, and its later chambers are slightly more slender. Such differences are, of course, of very little importance for specific separation in this group, as they are not constant.

Brady, Parker, and Jones recognized the close relationship between *Guttulina problema* and *Guttulina communis,* but they preferred to accept the models No. 61 and No. 62 as a basis of subdivision, while later Brady proposed to unite them in the *Challenger* report, although he gave separate names to the figures.

Reuss, when he described *Polymorphina problema* var. *deltoidea* in 1866,[6] placed together *Guttulina communis, Guttulina problema,* and *Guttulina austriaca;* this conclusion might have been guided by the figures in the Vienna Basin monograph. However, d'Orbigny's *Guttulina communis* figured in the Vienna Basin monograph is the same as Reuss's *Guttulina dilatata* described in 1851, and d'Orbigny's *Guttulina problema* in the same paper is nothing but a specimen having one more chamber than *Guttulina communis* (*Guttulina dilatata*). *Guttulina austriaca* is, as discussed later, quite different from the other two. The above discussion was confirmed by the study of both the holotypes and paratypes.

At first, we endeavored to separate *Guttulina problema* and *Guttulina communis,* but a study of the large accumulation of both fossil and

[6] Deutsch. d. Matem.-Natur. Classed. k. Akad. Wissens, vol. 25, p. 154.

recent specimens led us to unite them. The difference between them is only in the shape of chamber, more precisely the degree of elongation.

Guttulina cretacea Alth differs from the present species in its inflated chambers, and is close to *Globulina gibba* var. *glomula* Fornasini from the Pliocene of Siena which, according to Fornasini, is an intermediate between *Guttulina problema* and *Globulina gibba*. However, both *Guttulina cretacea* and *Globulina gibba* var. *glomula*, though they have slightly depressed sutures, retain the quinqueloculine arrangement of chambers, and they resemble *Guttulina problema* more than *Globulina gibba*. Therefore, they are included in *Guttulina problema*.

We have specimens referred to this species from the following localities: *Recent.*—*Albatross* D4807, off Japan; D5141, vicinity of Jolo, P. I.; D5469, east coast of Luzon, P. I.; D2756, off Brazil; shore sand, Rimini, Italy; off southwest Ireland; Dry Tortugas, Fla.

Pleistocene.—United States, Lomita quarry, Palos Verdes Hills, Calif.

Pliocene.—United States, Timms Point, San Pedro, Calif.

Miocene.—Germany, Dingden, Westphalia, Ortenburg; Hungary, Kostej, Banat; Tortonian sand, Varpolata; Austria, Bujtur, Siebenburgen; France, Burdigalien superieur, Pont Gourguet, Saucats; Burdigalien moyen, Le Coquillat, Leognan; Burdigalien inferieur, St. Paul de Dax; Moulin de l'Eglise, Saucats; Australia, Filter quarry, near Batesford, Victoria; Bird Rock Cliffs, Torquay, Victoria; Danger Point, Torquay, Victoria; lower beds, Muddy Creek; United States, Oak Grove sand, 100 yards below Oak Grove Bridge, Yellow River, Fla.; Chipola marl, Chipola River, Calhoun County, Fla.

Oligocene.—Germany, Upper Oligocene, Ahnatal, near Cassel; Doberg, near Bünde; middle Oligocene, Septarienthon, Hermsdorf, near Berlin; Flonheim, Mainz Basin; Wiesloch, near Heidelberg; Oeding, Westphalia; Düsseldorf; Hildesheimer Wald, near Dickholzen, Hanover; Lobsann, Alsace; United States, lower Oligocene, Red Bluff clay, Red Bluff, Wayne County, Miss.

Eocene.—United States, Jacksonian, Tarkiln Creek, one-half mile above Neuches River, Tex.; Cooper marl, South Carolina; Claibornian of Alabama, Mississippi, and Louisiana; Vincentown, N. J.; Cipero section, Trinidad, British West Indies; Midwayan, Texas; France, Lutetien, Parnes (Les Bôves); Vaudancourt; *Orbitolites* bed and Middle bed, Grignon; Campbon Liveau de Rilly, Damery; Belgium, Wansin.

Cretaceous.—Holland, upper Senonian, Maastricht; United States, Ripley formation, Owl Creek, Miss.; Upper Cretaceous, Texas.

GUTTULINA BULLOIDES (Reuss)

Plate 1, figures 7, 8

Globulina bulloides REUSS, Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 318, pl. 3, fig. 4.
Guttulina bulloides TERQUEM (?), Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 47, pl. 4 (9), figs. 27 *a*, *b*.
Globulina deformis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 27.
Polymorphina (*Globulina*) *deformis* FORNASINI, Riv. Ital. Pal., vol. 8, 1902, p. 3, pl. 1, fig. 9.

Test diagonally oval, nearly as wide as long, rounded at both ends; chambers inflated, rounded, slightly embracing, arranged in an almost clockwise, quinqueloculine series; sutures much depressed, distinct; wall smooth, thick; aperture radiate.

Length 0.40–1.50 mm.; breadth 0.40–1.40 mm.; thickness 0.25–0.75 mm.

The present species is characterized by rounded chambers, the last of which is much removed from the base. We have several specimens of the present species from the Miocene in the environs of Bordeaux which are just the same as Fornasini's figure. In its essential features, our specimens resemble *Globulina bulloides* described by Reuss from the Cretaceous of Maastricht. Our series of specimens shows that the species is a variable one.

Guttulina bulloides Terquem, having rounded chambers separated by deep sutures, seems perhaps to belong to the present species, but we have no topotype specimens for comparison.

Specimens in our collection which may be referred to this species with more or less question are from the following localities:

Recent.—Shore sand, Coffins Beach, Annisquam, Mass.; *Albatross* D2415, 440 fathoms, and D2416, 276 fathoms, both off the Carolina coast.

Pliocene.—Crag, Sutton, England.

Miocene.—France, Helvetian, Salles, Moulin du Minoy; Burdigalien, Moulin de l'Eglise, Saucats; St. Paul de Dax; Hungary, Lapugy; Trinidad, Cipero section.

GUTTULINA BARTSCHI Cushman and Ozawa, new species

Plate 1, figures 10 *a–c*

Test ovate, with broadly rounded end (young) to oblong (adult), initial end obtuse and rounded, apertural end acuminate; chambers inflated, slightly longer than wide, slightly embracing, arranged in a nearly quinqueloculine series; sutures depressed, distinct; wall smooth, thick, translucent; aperture radiate.

Length 0.50–0.70 mm.; breadth 0.35–0.60 mm.; thickness 0.30–0.45 mm.

Holotype.—(U. S. Nat. Mus. No. 12612.) From *Albatross* D5178, in 78 fathoms off Romblon, P. I.

It also occurs in the Philippines from the following stations: D5143, 19 fathoms and D5144, 19 fathoms, both off Jolo Jolo; D5152, 34 fathoms, Tawi Tawi group; D5268, 170 fathoms, Verde Island Passage; D5319, 340 fathoms, China Sea off Formosa. It also occurs at D4883, 53 fathoms, off Japan. We have specimens from off the Poor Knights Islands, New Zealand, in 60 fathoms, and from Van Diemans Inlet, Gulf of Carpenteria, Queensland, Australia, 10 fathoms. There are specimens in the collection from the lower Pliocene of Beaumaris, near Melbourne, Victoria, Australia.

The species is named after Dr. Paul Bartsch, of the United States National Museum, who collected much of the material in the *Albatross* cruise in the Philippines.

In general outline, *Guttulina bartschi* is similar to *Guttulina regina* distributed in the Indo-Australian region; but *G. bartschi* has a smooth surface.

GUTTULINA ORIENTALIS Cushman and Ozawa

Plate 3, figures 2, 3

Guttulina orientalis CUSHMAN and OZAWA, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 15, pl. 2, fig. 1; Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 66, pl. 13, fig. 1; pl. 14, figs. 1, 2.

Test ovate to broadly fusiform, greatest breadth usually slightly below the middle, base broadly rounded; chambers inflated, clavate, arranged in a clockwise, quinqueloculine series, each succeeding chamber farther removed from the base; sutures only slightly depressed, distinct; wall smooth, polished, thick; aperture radiate.

Length of adult specimens, 1.00–1.42 mm.; breadth, 0.65–0.83 mm.; thickness, 0.55–0.69 mm.

Guttulina orientalis most closely resembles *Guttulina problema*, from which it is distinguished by its more inflated chambers arranged much closer in a quinqueloculine series, and each succeeding chamber is removed much farther from the base. From *Guttulina austriaca* it is easily separated by its less depressed sutures, more rounded base, and inflated chambers.

Distribution.—The species occurs at numerous localities about Japan. The type locality is from the upper Pliocene of Sawane, Island of Sado, Japan. It occurs also in the upper Pliocene of Natsukawa, and there are numerous Recent specimens from off Kobama. In the *Albatross* dredgings, it occurs at D4826, 114 fathoms, D4843, 100 fathoms, both off Japan.

In addition, there is in the collection a single specimen of similar form in Doctor Bagg's material from Timms Point, Calif. It may be noted also that we have a very few specimens from the Miocene of

Bordeaux that in size and general arrangement of chambers are very similar.

GUTTULINA IRREGULARIS (d'Orbigny)

Plate 3, figures 4, 5; Plate 7, figures 1, 2

Globulina irregularis D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 226, pl. 13, figs. 9, 10.—CUSHMAN and THOMAS, Journ. Pal., vol. 3, 1929, p. 177, pl. 23, figs. 2*a–c*.

Guttulina dilatata REUSS, Denkschr. K. Akad. Wiss. Wien, vol. 1, 1850, p. 378, pl. 48, fig. 11.

Guttulina problema D'ORBIGNY (not d'Orbigny 1826), Foram. Foss. Bass. Tert. Vienne, 1846, p. 224, pl. 12, figs. 26–28.—REUSS, in Geinitz, Grundr. Verstein., 1845–46, p. 669, pl. 24, fig. 83.

Globulina guttula REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 82, pl. 6, fig. 46.

Guttulina semiplana REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 82, pl. 6, fig. 48.

Guttulina centrata TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 46, pl. 4 (9), figs. 25*a*–26.

Polymorphina byramensis CUSHMAN, U. S. Geol. Survey Prof. Paper 129–E, 1922, p. 94, pl. 17, figs. 2*a*, *b*; Idem, Prof. Paper 133, 1923, p. 31, pl. 5, figs. 1–5.

Guttulina byramensis CUSHMAN and SCHENCK, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 309, pl. 43, figs. 6–8.

Test oval to subdeltoidal, equilaterally triangular with rounded sides and angles, excepting the acute apertural end; chambers more or less angular, elongated, arranged in a clockwise, quinqueloculine series, each succeeding chamber excepting the last one or two chambers in full grown specimens coming down to the base; sutures depressed, distinct; wall smooth, but in full-grown specimens often having the last small chamber with spines or covered with fistulose tubes; aperture radiate.

Length, 0.45–1.40 mm.; breadth, 0.30–1.20 mm.; thickness, 0.20–0.75 mm.

Guttulina irregularis is closely related to *Guttulina problema* in its quinqueloculine arrangement of chambers and depressed sutures, and naturally it was recorded by most authors under the names of *Guttulina problema* or *Guttulina communis*. D'Orbigny himself described and figured the present species in the Vienna monograph as three different species, *Guttulina communis*, *Guttulina problema*, and *Globulina irregularis*. Ozawa examined both holotype and paratype specimens of the above three species as well as a great deal of material collected from the Vienna Basin Tertiary, and is convinced that the three species as used in the 1846 paper are really nothing more than one and the same organism in different phases of growth. "*Guttulina communis*" is the adult and most common form of d'Orbigny. *Guttulina problema* is an older stage with one more chamber, and *Globulina irregularis* represented by a somewhat

abnormal specimen having an irregular growth of chambers. There is some doubt about the holotype specimen of *Globulina irregularis* preserved in the Museum of Paris, because the specimen is also labelled "*Guttulina communis*, var.," and it is equilaterally triangular in outline instead of globular as figured by d'Orbigny. It would be considered that d'Orbigny's figures for *Globulina irregularis* are much modified from the specimen now in the museum as in the case of *Guttulina problema* and *Guttulina communis* in the same paper. There is no specimen like the *Globulina irregularis* figured by d'Orbigny, either in the paratype specimens or among our topotypes. Therefore, in this paper we take the specimen in the Museum at Paris as the holotype and give the somewhat abnormal specimen having the very inadequate name of *Globulina irregularis* the priority over several specific names given the specimens considered to be identical with the present species. It is to be noted here that *Polymorphina irregularis* d'Orbigny in the Cuban monograph is a different species from *Globulina irregularis* in the Vienna monograph in which *Globulina* is used as a genus.

Guttulina dilatata Reuss recorded from the Vienna Basin Miocene in 1850 is different from *Polymorphina dilatata* described by the same author in the following year 1851, and is a very good representation of the present species. Reuss' *Globulina guttula* and *Guttulina semiplana* from Hermsdorf are the same, the former being a young and the latter an adult. They are very close to *Guttulina irregularis* and are placed in the synonymy.

Guttulina centrata Terquem, having a rounded outline and much involute chambers is approaching *Sigmoidella*. This is shown in young stages of *Guttulina irregularis*. It appears not to be well drawn and is provisionally included in the present species.

Polymorphina byramensis Cushman, one of the most common species in the American older Tertiary, in its general features is closely related to the present species.

Distribution.—This is one of the most common species of the Polymorphinidae. It ranges from the Cretaceous to the Recent, and geographically is also widely distributed. We have specimens from the following localities referable to this species:

Recent.—Italy, shore sand, Lido, Venice; Australia, shore sand, Torquay, on Bass Strait, Victoria; New Zealand, off North Cape, 75 fathoms; off Oamaru, 50 fathoms; off the Big King, 98 fathoms; off Poor Knights Islands, 60 fathoms; east coast United States, *Albatross* D2415, off the Carolina coast, 440 fathoms; D2262, south of New England, 250 fathoms.

Pliocene.—Island of Cyprus, Lanarka; Italy, Coroncina, near Siena; Castel Arquato; Ponticello, near Bologna.

Miocene.—United States, Choctawhatchee marl, near Red Bay, Fla.; Chipola marl, Chipola River, Calhoun County, Fla.; Australia, Janjukian, Filter quarries, Batesford, Victoria; Bird Rock Cliffs, Torquay, Victoria; bore, Hopevale Station, Sutherlands Creek, near Geelong, Victoria; Balcombian, Kackeraboite Creek, Victoria; Austria, *Amphistegina*-marl and Leithakalk, Grunes Kreuz, Nussdorf, near Vienna; Tortonian, Loos, Vienna Basin; Hungary, Tortonian, Varpolata; Lapugy; Kostej; France, Helvetian, Pontlevoy; Salles, Moulin de Minoy; Burdigalien moyen, Le Coquillat, Leognan; Burdigalien recifal, St. Paul de Dax, Landes, Burdigalien inferieur, Moulin de l'Eglise, Saucats (Gironde).

Oligocene.—Germany, upper Oligocene, Ahnatal, near Cassel; middle Oligocene, Flonheim, Mainz Basin; Hermsdorf near Berlin; Pietzpuhl; Söllingen; Duisberg; Oeding; Düsseldorf, Dickholzen; Lobsann; lower Oligocene, Lattdorf; Australia, Clifton Bank, near Hamilton, Victoria; United States, Byram marl, Byram and Vicksburg, Miss.; Mint Spring Marl, Mint Spring Bayou, Vicksburg, Miss., and many other localities recorded; Mexico, numerous localities in Tampico embayment region.

Eocene.—United States, Jacksonian, 1½ miles south of Shubuta, Miss.; 1 mile south of Yazoo City, Miss.; west bank of Chipola River, east of Marianna, Jackson County, Fla., and many other stations.; Claibornian, Cook Mountain formation, Moseleys Ferry, Caldwell County, Tex.; Sabine County, Tex.; Alabama; Louisiana; Vincentown, N. J.; Midwayan, Naheola formation, Naheola Landing, Tombigbee River, Ala.; Midway, Tex. Mexico, many stations in Alazan clays, Guayabal formation, Guayabal. Trinidad, Hermitage quarry, Dumfries Road; Cipero section; Vistabella quarry. Hungary, Neustift, Ofen. Austria, Bartonian, Bruderndorf, near Stockerau. France, Lutetien, Parnes (Les Bôves); Damery; Chaussy; Grignon; Courtagnon. Italy, Bartonian, Val di Lonte. England, Bracklesham beds, White Cliff Bay, Isle of Wight. Belgium, basal Eocene, Wansin.

GUTTULINA IRREGULARIS d'Orbigny var. NIPPONENSIS Cushman and Ozawa, new variety

Plate 7, figures 3*a–c*

Variety differing from the typical in having the later chambers not much removed from the base and having a tendency to embrace the earlier ones; that is, it is approaching *Sigmoidella.* It is noteworthy that the direction of the quinqueloculine arrangement of chambers is either clockwise or contraclockwise as in *Sigmoidella pacifica.*

Length 0.70–0.75 mm.; breadth 0.45–0.55 mm.; thickness 0.33–0.37 mm.

Holotype of variety (Cushman Coll. No. 11140).—From upper Pliocene, Okuwa, Province of Kaga, Japan. Paratypes in Geological Institute, Imperial University of Tokyo, Japan.

The specimens having a contraclockwise arrangement of chambers, more or less resemble *Guttulina lactea*, but the sutures are more depressed and the outline is more triangular instead of the oval or ovate form of *Guttulina lactea*.

Distribution.—Found only in the Japanese Pliocene deposits and as a Recent form.

GUTTULINA FRANKEI Cushman and Ozawa, new species

Plate 4, figures 1 *a–c*

Polymorphina lactea var. *cuspidata* FRANKE, Abhandl. Mus. Nat. Magdeburg, 1925, p. 177, pl. 6, fig. 46*b*.

Test nearly quadrangular, almost symmetrical, apertural and initial ends very acute, forming opposite diagonal angles, other two angles rounded; chambers clavate, not embracing, earlier ones small, later ones much enlarged, arranged in a clockwise, quinqueloculine series; sutures depressed, distinct; wall smooth, rather thick; aperture radiate.

Length 0.60–0.82 mm.; breadth 0.35–0.55 mm.; thickness 0.25–0.35 mm.

Holotype (Cushman Coll. No. 10588).—From the middle Oligocene of Söllingen, Germany. We also have specimens from the Oligocene of Oeding, Westphalia, Germany. Very similar specimens occur in the upper Eocene, Cooper marl of South Carolina.

Guttulina frankei more or less resembles *Guttulina irregularis* in its general characters, but the former has the more acute base, often with a spine at its initial end. It differs from the microspheric form of *Guttulina irregularis* which has invariably a rounded base and is usually more or less equilaterally triangular.

Franke's *Polymorphina lactea* var. *cuspidata* reported from the lower Oligocene of Magdeburg is characterized by a cuspidate initial end and is very similar to the present species. However, the name *cuspidata* has already been used by Brady, and we have attached Doctor Franke's name to this species.

GUTTULINA TRIGONULA (Reuss)

Plate 4, figures 2 *a–c*

Polymorphina trigonula REUSS, Die Verstein. böhm. Kreide, 1845, p. 40, pl. 13, fig. 84.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 232, pl. 40, figs. 16*a*, *b*.

Polymorphina damaecornis REUSS, Die Verstein. böhm. Kreide, 1845, p. 40, pl. 13, fig. 85.

Polymorphina (*Guttulina*) *damaecornis* JONES and CHAPMAN, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 508, fig. 2 (in text).

Test spheroidal, truncate at the base, obtuse at the apertural end; chambers rounded, inflated, arranged in a clockwise, quinqueloculine series, each succeeding chamber extending back to the base but not

covering the earlier chambers at the base; sutures depressed, distinct; wall smooth, the apertural end often covered with fistulose tubes; aperture produced, radiate.

Length 0.35–0.70 mm.; breadth 0.35–0.65 mm.; thickness 0.25–0.48 mm.

Guttulina trigonula is allied to *Guttulina problema* and like it has the chambers arranged in a quinqueloculine series, but differs from it in the truncate, somewhat three-sided base. The test itself is much rounded and much wider than long. *Guttulina damaecornis* mentioned by Reuss in the same paper as the present species is undoubtedly a fistulose specimen of *Guttulina trigonula*.

Polymorphina glomerata Roemer [7] characterized by a spheroidal test composed of inflated and rounded chambers, appears to be very close to *Guttulina trigonula*, but the figures lack details. The fact also that we have no specimens in our collection that seem identical has left us in doubt whether it be a valid species or a synonym of the present one.

Distribution.—Reuss recorded the present species from the Cretaceous of Luschnitz in Bohemia. Our figured specimen was obtained from the lower Gault clay at Barnwell Pit, in Cambridge, England. The other localities of our specimens from the Cretaceous are: Maastricht, Holland; Stemmerberg, Westphalia; Hinter-Fessen near Pirna, Germany; Velasco shale, Hacienda El Limon, west of Panuco, Mexico.

GUTTULINA AUSTRIACA d'Orbigny

Plate 4, figures 3–5

Guttulina austriaca D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 223, pl. 12, figs. 23–25.—TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 133, pl. 13 (21), fig. 36.

Polymorphina oblonga D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 232, pl. 12, figs. 29–31.—TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 145, pl. 15 (23), fig. 9.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 569, pl. 73, fig. 4 (not figs. 2 and 3).—CHASTER, First Rept. Southport Soc. Nat. Sci., 1890–91 (1892), p. 64, pl. 1, fig. 13.—BAGG, U. S. Geol. Survey, Bull. 513, 1912, p. 73, pl. 20, figs. 10–12.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 88, pl. 37, fig. 6; Idem, Bull. 100, vol. 4, 1921, p. 268, pl. 52, fig. 3.

Polymorphina guttata REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 487.—v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 30, figs. 25–32.

Test fusiform to oblong, more or less rounded at the base, rather acute at the apertural end, often botryoidal, greatest breadth usually above the middle; chambers oval to clavate, slightly embracing, arranged in a clockwise, quinqueloculine series, each succeeding chamber removed much farther from the base; sutures depressed and very distinct; wall smooth, translucent; aperture produced, radiate.

[7] Verst. norddeutsch. Kreide, 1840–41, p. 97, pl. 15, fig. 19.

Length 0.60–1.15 mm.; breadth 0.40–0.55 mm.; thickness 0.35–0.50 mm.

Original specimen in Paris, paratypes in Vienna.

Guttulina austriaca has been often confused and mistaken by various authors. It is generally considered to be identical with *Guttulina problema* and *G. communis*. We do not deny its close relationship to *Guttulina problema*, because it has the same arrangement of clavate chambers, although in the present species each succeeding chamber is removed from the proloculum, which is always very distinct in a young specimen. In the plate are illustrated three phases of the growth of *Guttulina austriaca* from specimens collected from the original locality. The youngest is a specimen coinciding in every respect with d'Orbigny's *Guttulina austriaca*, and the largest adult specimen is nothing but the species described by d'Orbigny under the name *Polymorphina oblonga* (not of Roemer nor of Williamson).

Polymorphina guttula Reuss, a name given to the figures (pl. 30, figs. 25–30) of Schlicht, having a botryoidal test, is closely related to the present species.

Distribution.—We have specimens of this species from the following localities:

Recent.—Italy, Shore sand, Rimini; Pacific, off Watson's Bay, Port Jackson, New South Wales, Australia; Kobama, Japan; *Albatross* D5318, 340 fathoms, China Sea, vicinity of Formosa.

Pleistocene.—Canada, Glacial clays, McGill College Grounds, Montreal.

Pliocene.—Italy, Castel Arquato; Coroncina, near Siena; Belgium, Crag noir, Antwerp; Japan, Okuwa, Province of Kaga; Natsukawa, Province of Echigo.

Miocene.—Hungary, Kostej; Lapugy; Varpolata; Austria, Tortonian, Grunes Kreuz, Nussdorf; Perchtoldsdorf; Baden, near Vienna.

Oligocene.—Upper Oligocene, Germany, Ahnatal near Cassel. Middle Oligocene, Flonheim, Mainz Basin. Lower Oligocene, Lattdorf.

Eocene.—France, Lutetien, Parnes (Les Bôves); Lutetien moyen, Grignon. Lower Eocene, Belgium, Wansin.

GUTTULINA YABEI Cushman and Ozawa

Plate 4, figures 6, 7

Guttulina yabei Cushman and Ozawa, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 68, pl. 13, fig. 2; pl. 14, fig. 6.

Polymorphina oblonga H. B. Brady (not d'Orbigny), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 73, figs. 2, 3.

Test elongate fusiform, rounded, greatest breadth above the middle, base rounded; chambers numerous, inflated, one and one-half times as long as broad, arranged in a close sigmoid series, each chamber added with its base at about the middle of the previous chamber

adjacent to it; sutures very distinct, depressed; wall smooth, polished, thick, translucent; aperture radiate, terminal.

Length 1.50 mm.; breadth 0.75 mm.

Holotype.—(Geological Institute, Imperial University of Tokyo, Japan.) From the upper Pliocene, Sawane, Island of Sado.

This species is evidently the same as that figured by Brady.[8] Brady's specimens are from the Australian region, and are not the same as d'Orbigny's *Polymorphina* (*Guttulina*) *oblonga* from the Miocene of the Vienna Basin, which is a much smaller species as well as differing in other characters. Topotypes of d'Orbigny's species have been compared with the Japanese specimens.

In the *Albatross* collections, the species occurs at Stations D4807, 44 fathoms and D4826, 114 fathoms off Japan.

GUTTULINA YABEI Cushman and Ozawa var. OVALE Cushman and Ozawa

Plate 40, figure 6

Guttulina yabei CUSHMAN and OZAWA var. *ovale* CUSHMAN and OZAWA, Jap. Journ. Geol. and Geog., vol. 6, 1929, p. 68, pl. 13, fig. 3; pl. 14, fig. 7.

Variety differing from the typical form in having the sutures less depressed, and the chambers less inflated, due to the greater overlapping of the chambers. The figured specimen measured 2.5 mm. in length, and 1.1 mm. in breadth.

The types are from the upper Pliocene of Sawane, Island of Sado, Japan.

GUTTULINA SPICAEFORMIS (Roemer)

Plate 5, figures 1, 2

Polymorphina spicaeformis ROEMER, Neues Jahrb. für Min., 1838, p. 386, pl. 3, fig. 31.

Polymorphina austriaca d'ORBIGNY var. *io* CUSHMAN and APPLIN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 174, pl. 9, figs. 6, 7.

Guttulina plancii d'ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 60, pl. 1, fig. 5.

Polymorphina uviformis REUSS, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 289, pl. 11, fig. 5.

Test fusiform, initial end rounded, apertural end acute, margin slightly lobulate; chambers clavate, but little embracing, arranged in a contraclockwise, quinqueloculine series, each succeeding chamber removed from the base; sutures depressed, distinct; wall smooth; aperture radiate.

Length 0.35–0.75 mm.; breadth 0.20–0.35 mm.; thickness 0.12–0.25 mm.

In general form, *Guttulina spicaeformis* most resembles *Guttulina austriaca* d'Orbigny from the Vienna Basin in that it has rather short, clavate chambers combined so as to form a typical fusiform test. It

[8] Challenger Report, vol. 9, 1884, pl. 73, figs. 2, 3.

however possesses a contraclockwise quinqueloculine arrangement of chambers as distinctly shown in the figure given by Roemer.

Polymorphina uviformis Reuss may represent a Cretaceous specimen of the present species, and we have no reason to separate it from *Guttulina spicaeformis.*

Guttulina plancii d'Orbigny described from the Bay of San-Blas, Patagonia, and *Polymorphina austriaca* var. *io* Cushman and Applin are also placed under the synonymy of the present species.

Distribution.—Geologically and geographically *Guttulina spicaeformis* is widely distributed. We have species from the following localities:

Recent.—Atlantic, West Indies, Dry Tortugas, 11 and 18 fathoms; San Juan Harbor, P. R., 6 fathoms; coast of Belgium; Gaspé Bay, 10–15 fathoms; Australia, Hardwick Bay, east side of Spencer Gulf; New Zealand, off the Big King, 98 fathoms; off the Snares; Oamaru.

Miocene.—Australia, Filter Quarry, Batesford, Victoria.

Oligocene.—Germany, Düsseldorf; Söllingen; Oeding, Westphalia.

Eocene.—United States, Cooper marl, west side of Biggin Creek, Berkeley County, S. C.; Ocala limestone, west bank of Chipola River, at Wagon Bridge, east of Marianna, Jackson County, Fla.; east bank of Sepulga River, north of Brooklyn, Conecuh County, Ala.; road from Perdue Hill to Claiborne, Monroe County, Ala.; Jacksonian, Jackson, Miss.; bluff on Garlands Creek, 5 miles northeast of Shubuta, Wayne County, Miss.; bluff on Chickasawhay River at Hayes Chapel, Wayne County, Miss.; Stovall Creek, east of Diboll, Tex.; three-fourths mile below Robinson's Ferry, Sabine River, Sabine, Tex.; Wilmington, N. C., Claibornian; roadside going down to river, Claiborne, Ala.; Midwayan, Tex. England, Bracklesham beds X, XIII, XVIII, Isle of Wight. Thanetian, Pegwell Bay. France, Lutetien, Parnes (Les Bôves), Damery.

GUTTULINA SPICAEFORMIS (Roemer), var. AUSTRALIS (d'Orbigny)

Plate 5, figures 3 *a–c*

Globulina australis d'Orbigny, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 60, pl. 1, figs. 1–4.

Polymorphina australis H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1869, p. 239, pl. 41, figs. 27*a*, *b*.

Polymorphina regina Cushman, U. S. Geol. Survey Prof. Paper 129, 1921, p. 94, pl. 18, fig. 4; Carnegie Instit. Washington, Publ. No. 311, 1922, p. 33, pl. 4, figs. 5, 6; U. S. Geol. Survey Prof. Paper 133, 1923, p. 33.

Variety differing from the typical in its ornamentation, consisting of fine, longitudinal costae, generally well developed on the lower half of the test. There are intermediate specimens in which the markings become obscure.

Length 0.45–0.63 mm.; breadth 0.25–0.32 mm.; thickness 0.18–0.25 mm.

Distribution.—This variety has occurred in considerable numbers at various stations off the Dry Tortugas, off Florida, and off Cuba. Specimens of very similar character and seemingly identical occur in the Eocene, Bracklesham beds XVII and XVIII, Isle of Wight, England, and in the lower Oligocene, Byram marl of Byram, Miss.

GUTTULINA HANTKENI Cushman and Ozawa, new species

Plate 5, figures 4–6

Polymorphina acuta HANTKEN, Mitth. Jahrb. K. Ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 60, pl. 8, fig. 4 (*acuminata* on explanation of plate).

Test oval, botryoidal, more or less rounded at the base, acute at the aperture, greatest breadth above the middle; chambers ovate, embracing but little, arranged in a contraclockwise, quinqueloculine series, each succeeding chamber removed farther from the base sutures much depressed, very distinct; wall smooth, thick; aperture acutely produced, radiate.

Length 0.60–1.20 mm.; breadth 0.35–0.75 mm.; thickness 0.30–0.60 mm.

Holotype.—(Cushman Coll. No. 11194.) Eocene, Kleinzellen, bei Ofen, Hungary.

Guttulina hantkeni has a typical botryoidal test consisting of ovate chambers, while other botryoidal species such as *Guttulina austriaca* and *Guttulina spicaeformis* have invariably more slender tests consisting of clavate chambers.

The Cretaceous *Polymorphina uviformis* Reuss, which is included in *Guttulina spicaeformis* (Roemer) in this paper, seems to represent an intermediate form between *Guttulina hantkeni* and *Guttulina spicaeformis*. Both Hantken's names, *Polymorphina acuta*, and *Polymorphina acuminata*, given to the present species, are preoccupied; therefore a new specific name is proposed, named for Doctor Hantken.

Distribution.—*Guttulina hantkeni* seems to be limited in its geological distribution. Our specimens were obtained from the Eocene formations of Neustift, Ofen, Hungary, the type locality of Hantken's specimens, also from the middle Eocene of the United States, Claibornian, of New Jersey and Louisiana. We also have specimens from the upper Senonian of Maastricht, Holland, which are very similar.

GUTTULINA PULCHELLA d'Orbigny

Plate 5, figures 7 *a–c*

Guttulina pulchella D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, vol. 6, 1840, p. 129, pl. 2, figs. 4–6.

Polymorphina pulchella H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 239, pl. 41, figs. 28 *a*, *b*.—CUSHMAN, Carnegie Instit. Washington, Publ. No. 311, 1922, p. 33, pl. 4, figs. 7, 8; Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 157, pl. 40, fig. 6.

Test elongate fusiform, greatest breadth slightly below the middle; chambers elongate, clavate, scarcely overlapping, arranged in a contra-

clockwise, quinqueloculine series, each succeeding chamber farther removed from the base; sutures depressed, distinct; wall thin, ornamented with fine, regular, longitudinal costae; aperture radiate.

Length 0.60–0.95 mm.; breadth 0.25–0.30 mm.; thickness 0.18–0.23 mm.

Guttulina pulchella is one of a few well-defined species among the Polymorphinidae described by d'Orbigny. Its slender, elongate chambers, marked with regular, longitudinal costae, are its characteristics and can not be confused with any of the other known species.

Distribution.—D'Orbigny recorded the present species from the shore sand of Cuba and Martinique. We have specimens from numerous stations off the Dry Tortugas, near Florida, 7–18 fathoms, and from *Albatross* D2420 off the eastern coast of the United States in 104 fathoms.

GUTTULINA REGINA (H. B. Brady, Parker, and Jones)

Plate 6, figures 1, 2

Polymorphina regina H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 241, pl. 41, figs. 32 *a*, *b*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 571, pl. 73, figs. 11–13.—Egger, Abhandl. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 310, pl. 9, figs. 45, 50, 51.—Chapman, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 132, pl. 10, fig. 4.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 91, pl. 41, figs. 6, 7; Bull. 676, U. S. Geol. Survey, 1918, p. 54, pl. 11, figs. 3, 4; Prof. Paper 129–E, 1922, p. 94, pl. 18, fig. 4; Prof. Paper 129–F, 1922, p. 131, pl. 30, fig. 8.

Test broadly fusiform, obtuse and rounded at the initial end, acute at the apertural end; chambers inflated, oval, but little embracing, arranged in a quinqueloculine series, each succeeding chamber rapidly enlarged, removed slightly from the base; sutures much depressed, distinct; wall marked by equidistant, longitudinal costae; aperture radiate.

Length 0.63–0.80 mm.; breadth 0.35–0.42; thickness 0.25–0.35 mm.

This is a well-defined species described by H. B. Brady, Parker, and Jones, and there is but little danger of confusing it with any other species of the genus.

The surface markings are very regular and distinct, although in some specimens they are much finer.

Distribution.—The original authors reported it from soundings from Storm Bay, Tasmania. It is common off the eastern coast of Australia. We have specimens from *Albatross* D5152, 34 fathoms, Sulu Archipelago; D5311, 88 fathoms, China Sea, off southern Luzon, P. I.; shore sand, Torquay, on Bass Strait, Victoria, Australia; shore sand, Newcastle Bay, New South Wales; Van Dieman's Inlet, Gulf of Carpenteria, Queensland, 10 fathoms; and Wool Bay, Yorkes Peninsula, west side of St. Vincent Gulf, South Australia.

GUTTULINA REGINA (H. B. Brady, Parker, and Jones) var. CRASSICOSTATA Cushman and Ozawa, new variety

Plate 11, figures 5 *a–c*

Variety differing from the typical in the very broad, coarse costae and in the shape of the test, which instead of having the greatest breadth decidedly below the middle has a more regularly fusiform test; the chambers not as inflated as in the typical form.

Holotype of variety.—(Cushman Coll. No. 11891.) From the lower Pliocene, Beaumaris, near Melbourne, Victoria, Australia.

This variety is very distinct from the typical form. The costae are extremely thick and heavy, even more so than shown in the figure.

GUTTULINA COSTATULA Galloway and Wissler

Plate 6, figures 3 *a, b*

Polymorphina (*Guttulina*) *costatula* GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 57, pl. 9, figs. 10 *a, b*.

Test short, somewhat fusiform, acute at both ends; chambers inflated, rounded, not much embracing, arranged in a contraclockwise, quinqueloculine series, each succeeding chamber removed much farther from the base; sutures depressed, distinct; wall ornamented with numerous distinct, rounded costae, of which there are five more strongly developed at the base, radiating from the acute initial end independent of the sutures and taking positions in accord with the quinqueloculine arrangement of the early chambers; aperture produced, radiate.

Length 0.40–0.60 mm.; breadth 0.27–0.35 mm.; thickness 0.18–0.24 mm.

Guttulina costatula is very close in its general outline and ornamentation to *Guttulina regina* (H. B. Brady, Parker, and Jones), but it has generally much smaller dimensions, and its five strong costae radiating from the initial end is an important character developed in only one other known species of *Guttulina*. It is an ornamented species close to a rather common species found in the same locality (*Guttulina quinquecosta* Cushman and Ozawa), which has a smooth wall excepting for the five strong costae developed at the basal region. It grows much larger than the present species.

Distribution.—The types were described from the Pleistocene, lower bed, of the Lomita Quarry, Palos Verdes Hills, 2 miles south of Lomita, Calif. We have specimens from the type locality, and also specimens that seem to be identical from the Miocene of Filter Quarry, Victoria, Australia.

GUTTULINA CAUDATA d'Orbigny

Plate 6, figures 4, 5

Guttulina caudata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 16.—Fornasini, Boll. Soc. Geol. Ital., vol. 19, 1900, p. 137, fig. 2 (in text).

Test unequally compressed, front view nearly an isosceles triangle, with broadly rounded base, the initial end with a spine; chambers elongate, arranged in a clockwise, quinqueloculine series, each succeeding chamber nearly reaching to the base; sutures but little depressed, distinct; wall smooth; aperture radiate.

Length 0.32–0.48 mm.; breadth 0.20–0.35 mm.; thickness 0.08–0.15 mm.

This is one of the species listed by d'Orbigny in 1826 and figured much later by Fornasini. Its regular triangular outline with the spine at the initial end are important features which will distinguish *Guttulina caudata*. The quinqueloculine arrangement of the chambers of the species is very regular.

Distribution.—D'Orbigny listed it from the Adriatic Sea and as fossil from France and Castel Arquato. We have fossil specimens from France from the Eocene, Lutetien of Parnes (Les Bôves), Vaudancourt, and Beauves.

GUTTULINA ADHAERENS (Olszewski)

Plate 1, figures 9 *a–c*; Plate 6, figures 7 *a*, *b*

Polymorphina adhaerens Olszewski, Sprawodz. Kom. Fizyj. Akad. Umiej. Krakowie, vol. 9, 1875, p. 119, pl. 1, fig. 11.

Test ovate, broadest below the middle, rounded at the base, acute toward the apertural end; chambers clavate, arranged in an almost quinqueloculine series, each succeeding chamber slightly removed from the base; sutures but little depressed, distinct; wall smooth; aperture radiate.

Length 0.50–1.10 mm.; breadth 0.35–0.80 mm.; thickness 0.22–0.50 mm.

The quinqueloculine arrangement of the chambers of the present species has a tendency to become triserial. Accordingly a side view often shows only three chambers of which the middle one seems to be much inflated and produced between the others. This appearance is very characteristic of the species.

Distribution.—Rather common in various Cretaceous deposits in Europe, especially in the Chalkmarl and the Gault of England. We have it also from the Cretaceous of Maastricht, Holland.

GUTTULINA ADHAERENS (Olszewski) var. CUSPIDATA Cushman and Ozawa, new variety

Plate 6, figure 6

Polymorphina species, BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 561, pl. 11, fig. 15.

Variety differing from the typical in the development of a distinct basal spine.

Length including spine 0.50–0.65 mm.; breadth 0.30–0.45 mm.; thickness 0.18–0.30 mm.

Holotype of variety.—(Cushman Coll. No. 11209.) From the Cretaceous, chalk marl of Folkestone, England.

This variety is abundant in our collections from the chalk marl and Cambridge Greensand of the Saxon Cement Works, at Cambridge, England. Burrows, Sherborn, and Bailey's specimen was from the Red Chalk in England. We also have it from the lower Cenomanian, Tecklenburg Wald, Westphalia, Germany.

GUTTULINA PRAELONGA (Egger)

Plate 6, figures 8 *a–c*

Polymorphina praelonga EGGER, Neues Jahrb. für Min., Jahrg., 1857, p. 287, pl. 13, figs. 25–27.—TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 39, pl. 3 (8), figs. 20–21*b*.—JONES and CHAPMAN, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 511, fig. 20 (in text).—BAGG, Maryland Geol. Surv. (Eocene), 1901, p. 249, pl. 63, fig. 14.

Polymorphina (*Globulina*) *angusta* EGGER, Neues Jahrb. für Min., Jahrg. 1857, p. 290, pl. 13, figs. 13–15.—ANDREAE, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, pt. 3, 1884, p. 210, pl. 9, fig. 17.—EGGER, Abhandl. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 308, pl. 9, figs. 5–7.

Guttulina austriaca D'ORBIGNY var. *angusta* TERQUEM, Essai Class. Anim. Dunkerque, 1881, p. 130, pl. 17, fig. 5*a*, *b*.

Polymorphina dispar TERQUEM, Essai Class. Anim. Dunkerque, 1881, p. 130, pl. 17, fig. 4*a*, *b*.

Test elongate, more or less cylindrical, broadest below the middle, tapering toward the aperture, rounded at the initial end; chambers elongate, clavate, arranged in a quinqueloculine series, not much embracing; sutures depressed, distinct; wall smooth; apertural end often with fistulose tubes; aperture radiate.

Length 0.45–0.95 mm.; breadth 0.22–0.38 mm.; thickness 0.10–0.16 mm.

We have examined a paratype specimen of Egger's *Polymorphina praelonga* and are convinced that it is identical with *Polymorphina angusta* described by him in the same paper. Egger's *Polymorphina praelonga* is a full-grown specimen having one or two more chambers than *Polymorphina angusta*. The figures of *Polymorphina praelonga* Egger show the chambers arranged in a biserial series, but they are undoubtedly not well drawn.

Terquem figured and described *Polymorphina praelonga* in 1878, which is the same as *Polymorphina angusta* Egger.

Terquem's *Guttulina austriaca* var. *angusta* and *Polymorphina dispar* are also placed in the synonymy of the present species. The former has a slightly shorter test.

The latter appears to have one or two more chambers than the usual specimens of *Polymorphina praelonga.*

Polymorphina cylindrica Prochazka having a cylindrical test consisting of rather short chambers, is not much different from *Polymorphina angusta* or *Polymorphina austriaca* var. *angusta* Terquem.

Distribution.—Egger's types are from the Miocene. We have a paratype of Egger's from Ortenburg. The species occurs also in the Miocene of France at Dax and Le Coquillat, Leognan, France, as well as in the upper Oligocene (Stampien) of Jeurs, France. All these localities have a fauna very closely related to that described by Egger. Somewhat similar specimens occur in widely different localities such as the upper end of Buzzards Bay, Mass., Kobama, Japan; Wool Bay, Yorkes Peninsula, west side of St. Vincent Gulf, Australia. Somewhat similar specimens occur in the Pliocene of Fiji and in the Eocene of the Isle of Wight, England, Grignon and Parnes (Les Bôves), France, and in the Jackson of the United States. It is probable that these do not all represent a single species, but the specimens have a very similar arrangement and shape of the chambers. Some are clockwise and others contraclockwise in their arrangement, but the distinction does not seem to be constant.

GUTTULINA GUTTIFORMIS (Terquem)

Plate 6, figures 9 *a–c*

Polymorphina guttiformis TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 42, pl. 9 (14), fig. 24 *a*, *b*.

Test slender, in front view an isosceles triangle, broadest at the base, tapering toward the apertural end; chambers cylindrical, arranged in a quinqueloculine series, but little embracing, all extending back nearly to the base; sutures depressed, distinct; wall smooth; aperture radiate.

Length 0.65–0.90 mm.; breadth 0.25–0.35 mm.; thickness 0.16–0.24 mm.

This is one of the well marked species of *Guttulina.* Its test is elongated, but it is quite different from other elongate Guttulinas characterized by a botryoidal test, in having the chambers all extending down to the base. The nearest ally of the present species is *Guttulina praelonga* in which the chambers are much more inflated.

Distribution.—We have specimens from the following localities:

Miocene.—Burdigalien, France, St. Paul de Dax; Moulin de l'Eglise, Saucats.

Oligocene.—Germany, Ahnatal, near Cassel; Hildesheimer Wald, Dickholzen, Hanover.

GUTTULINA JARVISI Cushman and Ozawa, new species

Plate 7, figures 4, 5

Test ovate, greatest breadth near the middle, broadly rounded at the base, more or less acute at the apertural end; chambers inflated, twice as long as wide, not much embracing, arranged in a clockwise, quinqueloculine series, each succeeding chamber removed regularly from the base giving a rounded appearance at the base; sutures depressed, distinct; wall smooth, thick; aperture radiate.

Length 0.90–1.80 mm.; breadth 0.80–1.50 mm.; thickness 0.50–1.00 mm.

Holotype.—(Cushman Coll. No. 11226.) From Tertiary, lower marl, Cipero section, Trinidad.

The present species is generally very large, attaining to nearly 2 millimeters in length. In its general appearance, it has an intermediate character between *Guttulina problema* and *Guttulina hantkeni*. From the former it differs in its rather broad base and much obliquely added chambers, and from the latter in its more or less elongate chambers, of which each succeeding one is not much removed from the base.

Distribution.—Several specimens were found in the Tertiary material from Trinidad, collected by P. W. Jarvis. They are from the Eocene of the Cipero section and also from the "Uvigerina bed" and the "upper marl" of the same part of the island. We have a single specimen from *Albatross* D5318 off the Philippines which is very close to this species from Trinidad.

GUTTULINA LEHNERI Cushman and Ozawa, new species

Plate 8, figures 1, 2

Test ovate to clavate, broadest in the lower half, broadly rounded at the base, tapering to the apertural end; chambers elongated, embracing, arranged in a regular, quinqueloculine series; sutures not depressed, not very distinct; wall smooth, thick, often with fistulose tubes at the apertural portion; aperture radiate.

Length 0.65–1.35 mm.; breadth 0.38–0.55 mm.; thickness 0.25–0.36 mm.

Holotype.—(Cushman Coll. No. 10436.) From Tertiary, lower marl, south end of Hospital Hill, San Fernando, British West Indies.

Guttulina lehneri resembles *Guttulina problema* in general character, but it has elongated but not inflated chambers and nondepressed sutures, therefore its surface is quite even, and at a glance it can be easily separated from other Guttulinas. It is approaching *Globulina*, but the chambers are arranged in a regular quinqueloculine series.

Distribution.—Rather common in the Tertiary of Trinidad. It occurs in the "lower marl" of the Cipero section and also in the "Sagrina beds" of Oropouche Lagoon, Trinidad.

GUTTULINA YAMAZAKII Cushman and Ozawa, new species

Plate 8, figures 3, 4

Test elongate, the base broadly rounded, uniformly tapering toward the apertural end; chambers elongated, especially in the later ones, arranged in a quinqueloculine series, each succeeding chamber slightly removed from the base; sutures but little depressed, distinct; wall smooth, rather thick; aperture radiate.

Length 0.80–1.35 mm.; breadth 0.35–0.65 mm.; thickness 0.20–0.45 mm.

Holotype.—(Cat. No. 20950, U. S. N. M.) From *Albatross* D4807, in 44 fathoms off Cape Tsiuka, Japan.

The elongated test composed of elongated chambers is very characteristic of the present species. The specific name is dedicated to Prof. N. Yamazaki, Geographical Institute, Imperial University of Tokyo.

Distribution.—The species occurs living off Japan, and is fossil in the upper Pliocene.

Recent.—*Albatross* D4807, off Cape Tsiuka, Japan, 44 fathoms. Tuscarora 11, in 437 fathoms.

Pliocene.—Natsukawa, Province of Echigo, Japan.

GUTTULINA KISHINOUYI Cushman and Ozawa, new species

Plate 8, figures 5, 6

Test elongated, the greatest breadth in the lower half, broadly rounded at the base but pointed at the initial end, gradually tapering toward the aperture; chambers much elongated, roundly triangular in cross section, embracing, arranged in a clockwise quinqueloculine series, each succeeding chamber but little removed from the base; sutures slightly depressed, distinct; wall smooth, polished; aperture radiate.

Length 0.52–0.95 mm.; breadth 0.30–0.40 mm.; thickness 0.18–0.25 mm.

Holotype.—(Cushman Coll. No. 11234.) From the upper Pliocene, Natsukawa, Province of Echigo, Japan. (Paratypes, Geological Institute, Imperial University of Tokyo, Japan.)

The present species resembles *Guttulina yamazakii* found in the same region in its elongated test composed of long chambers. However, it has more slender chambers which are invariably but little removed from the base, and the chambers are embracing and much more strongly involute than those of *G. yamazakii*. The species is named for the late Professor Kishinouyi, of Japan, whom we both claimed as a friend.

Distribution.—Recent specimens are from *Albatross* dredgings, China Sea, off Formosa, D5315, in 148 fathoms, and D5585 Sibuko Bay, Borneo in 476 fathoms. It also occurred at *Tuscarora* 11, lat. 33° 46′ N., long. 140° 21′ E. in 437 fathoms.

GUTTULINA BAILEYI Cushman and Ozawa, new species

Plate 9, figures 1, 2

Test large, ovate, broadly rounded at the base; chambers elongated, especially the later ones, numerous, not much embracing, arranged in a quinqueloculine series, each succeeding chamber removed farther from the base in the early stage, but little in the later stage; sutures depressed, but not very distinct; wall thick, smooth; aperture radiate.

Length 1.15–1.55 mm.; breadth 0.70–0.80 mm.; thickness 0.50–0.60 mm.

Holotype.—(Cat. No. 20951, U.S.N.M.) From *Albatross* D2416, lat. 31° 26′ N., long. 79° 07′ W., in 276 fathoms off the southeastern coast of the United States.

The present species is one of the largest among our collection of Polymorphinidae. Its early stage is just the same as *Guttulina problema*, but it has more numerous chambers, and the later chambers are much elongated and often added in a spiral series. It may be interesting to compare the present species with *Sigmomorpha crassa*, which is very large and in its early stage resembles *Guttulina problema*, but later the chambers are more or less shortened and added in a sigmoid series instead of a quinqueloculine series as in the present species. It is named for Prof. J. W. Bailey, one of the early American workers on the foraminifera.

Distribution.—Besides the type locality, we have material very similar from *Albatross* D5151, 24 fathoms, Tawi Tawi Group, Philippines.

GUTTULINA ROEMERI (Reuss)

Plate 9, figures 3 *a–c*

Globulina roemeri Reuss, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 245, pl. 6, fig. 63.

Guttulina deformata Reuss, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 245, pl. 6, fig. 64.

Polymorphina uvula Egger, Neues Jahrb. für Min., Jahrg. 1857, p. 285, pl. 10, figs. 26–29.

Guttulina dubia Awerinzew, Mem. Acad. Imp. Sci. St. Petersbourg, vol. 29, No. 3, 1911, p. 19, pl., figs. 4 *a–d*.

Polymorphina deflexa Grzybowski, Mikrofauna Karpackiego piaskowka Z. Pod. Dukli Krakowie, 1894, p. 16, pl. 3, figs. 1, 2.

Polymorphina sororia Chapman, Bull. Geol. Surv., W. Australia, No. 72, 1917, p. 34, pl. 10, fig. 92.

Test ovoid to oblong, almost roundly triangular in the end view, the greatest breadth above the middle, rounded at the base; chambers inflated, oval, embracing, arranged in a nearly triserial series; sutures slightly depressed, distinct; wall thick, smooth; aperture radiate.

Length 0.70–1.80 mm.; breadth 0.50–1.00 mm.; thickness 0.38–0.75 mm.

In its general aspect excepting for the depressed sutures, *Guttulina roemeri* bears much resemblance to *Globulina rotundata*. It is not difficult to separate them if one examines closely their earlier stages. By taking off one chamber from such specimens as *Globulina obtusa* or *G. globosa* figured by Bornemann, they are very close to *Globulina gibba*. On the other hand, *Guttulina roemeri* is undoubtedly derived from such a form as *Guttulina problema* by losing the quinqueloculine arrangement of chambers and the chambers becoming more inflated and embracing. The sutures, therefore, are always more or less depressed.

Globulina roemeri figured by Reuss appears to us not to represent the typical form of the species. Although its sutures are depressed, it resembles *Globulina rotundata* in its general aspect.

Guttulina deformata described by Reuss in the same paper as the above species, with its test almost triangular in the end view is close to Grzybowski's *Polymorphina deflexa* from the Miocene of Europe.

Such a form as the latter is of the most common occurrence in various deposits. In the synonymy of the present species, Egger's *Polymorphina uvula* may be placed with some doubts. Egger's specimens are apparently very variable, but they have invariably triangular sections and the chambers are separated by the depressed sutures and arranged in a nearly triserial series. Awerinzew's *Polymorphina dubia* is close to the present species, the difference being mainly in the one extra chamber, and is undoubtedly to be placed in the synonymy of the present species.

Distribution.—Specimens referred to this species are in our collection from the following localities:

Recent.—Off Tripoli.

Pliocene.—Crag of Sutton, England.

Miocene.—Austria, Tortonian, *Amphistegina* marl of Grunes Kreuz, Nussdorf, Vienna. France, Burdigalien moyen, Le Coquillat, Leognan. United States, Choctawhatchee marl, Red Bay, Fla.

Oligocene.—Germany, Ahnatal, near Cassel; Doberg, near Bünde. Mexico, near Cuesta Blanca, Zacamixtle, Vera Cruz.

GUTTULINA ROEMERI (Reuss) var. GIGAS (Karrer)

Plate 9, figures 4 *a–c*

Polymorphina gigas KARRER, Abhandl. k. k. geol. Reichsanst, vol. 9, 1877, p. 384, pl. 16 *b*, fig. 44.

Variety differing from the typical by the more compressed and compact test and less depressed sutures with the apertural end more tapering.

Length 0.75 mm.; breadth 0.38 mm.; thickness 0.35 mm.

Ozawa examined the original specimen in the Museum of Natural History, Vienna, and found that the species is very close to *Guttulina*

roemeri in its general aspects. We have three specimens from the original locality: Tortonian, Grunes Kreuz, Nussdorf, Vienna Basin, Austria.

GUTTULINA LACTEA (Walker and Jacob)

Plate 10, figures 1–4

Serpula tenuis ovalis laevis WALKER and JACOB, Test. Min., 1784, p. 2, pl. 1, fig. 5.

Serpula lactea WALKER and JACOB (fide Kanmacher), Adams Essays, ed. 2, 1798, p. 634, pl. 14, fig. 4.

Polymorphina lactea WILLIAMSON, Recent Foram. Gt. Britain, 1858, p. 70, pl. 6, figs. 145–152.—H. B. BRADY, Proc. Somerset Arch. Nat. Hist. Soc., vol.13, 1865–66 (1867), p. 114, pl. 3, fig. 49.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 213, pl. 39, figs. 1 *a*, *b* (not 1 *c*).—TERQUEM, Essai Class. Anim. Dunkerque, 1875, p. 37, pl. 5, fig. 12; 1876, p. 79, pl. 10, figs. 19, 20.—BAGG, U. S. Geol. Survey, Bull. 513, 1912, p. 71, pl. 21, fig. 12 (not fig. 16 *a*, *b*).—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 146, pl. 39, fig. 9 (not fig. 11).

Guttulina lactea OZAWA, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 36, pl. 6, figs. 6–10.

Guttulina deplanata REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 246, pl. 6, fig. 67.

Test ovate, rounded triangular in section, tapering but little, rounded at the base; chambers elongate, somewhat compressed, arranged in a contraclockwise, quinqueloculine series, often tending to become a sigmoid series, each succeeding chamber very slightly removed from the base; sutures depressed, distinct; wall smooth, translucent; aperture radiate.

Length 0.60–0.85 mm.; breadth 0.35–0.40 mm.; thickness 0.20–0.28 mm.

This is the earliest figured species belonging to the family of the Polymorphinidae, obtained in the sand of the seashore near Sandwich, England. Although the figures are small and can be hardly considered as well drawn, and moreover, the description being very simple, yet they are sufficient to show that the figured specimen has a rather compressed test, the chambers of which are arranged in a contraclockwise, quinqueloculine series, and in these respects it has the same characters as one of the forms figured by Williamson in the Foraminifera of Great Britain, 1858.[9] Williamson's other two figures identified as *Polymorphina lactea* are different from Figure 147 in their acute initial end and biserial arrangement of later chambers. They are similar to *Polymorphina subcompressa* d'Orbigny (=*Polymorphina compressa* d'Orbigny). Such a biserial *Polymorphina* is also described by Fleming under the name of *Vermiculum lacteum* as early as 1822. Williamson's figure is well drawn and was taken by Brady, Parker, and Jones as a typical specimen representing *Poly-*

[9] Pl. 6, fig. 147.

morphina lactea in their monograph of the Genus *Polymorphina*. They apparently fixed the species very well, but they placed many different species in the synonymy of *Polymorphina lactea*, which led later authors into confusion, and since the publication of their paper the name *Polymorphina lactea* has been used very often, and accordingly the species has been mistaken. Probably no other species in Foraminifera has been more misunderstood than the present one.

We have examined shallow sea foraminiferal material obtained from off England, Ireland, and Iceland and isolated many specimens which can be identified with *Polymorphina lactea*, which are tolerably definite in their essential characters—ventricose test with depressed sutures, the elongate chambers arranged in a contraclockwise, quinqueloculine series—but often the test tends to become compressed by losing the quinqueloculine arrangement of chambers, that is, the later chambers have a tendency to be arranged in a sigmoid series.

Guttulina deplanata, described by Reuss in 1856 from the upper Oligocene of Cassel, Germany, is a compressed variety of the present species. It is rather common in the sand of Cassel, and we have many specimens from Cassel which show the same range of variation as does *Guttulina lactea* in a series of Recent specimens.

Distribution.—This is one of the most common species found in the shallow sea off England, Iceland, and Ireland. In the fossil state it is not as common as in the Recent. We have the species from the following localities:

Recent.—Ten miles off Glencoe, southwest Ireland, 53 fathoms; Nymph Bank, south of Cork Harbor, Ireland, 52½ fathoms; off Bantry Bay, southwest Ireland, 100 fathoms; coast of Belgium; Coast of Iceland; Labrador; bathing beach, Newport, R. I.; Dry Tortugas, Fla., 18 fathoms; Montego Bay, Jamaica; *Albatross* D2112, Caribbean, 15½ fathoms; D2614, east coast United States, 16 fathoms; D4856, coast of Japan, 898 fathoms; D5311, Philippines.

Pliocene.—Japan, Natsukawa, Province of Echigo. Italy, Castel Arquato.

Miocene.—France, Burdigalien inferieur, Moulin de l'Eglise, Saucats; Le Coquillat, Leognan.

Oligocene.—Germany, Ahnatal, near Cassel; Hildesheimer Wald, Dickholzen, Hanover.

Eocene.—France, Lutetien, Parnes (Les Bôves); Lutetien moyen, Grignon.

GUTTULINA LACTEA (Walker and Jacob) var. EARLANDI Cushman and Ozawa, new variety

Plate 10, figure 5

Polymorphina concava JONES (not Williamson), Foram. Crag, pt. 3, 1896, p. 264, pl. 5, fig. 22.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1909, p. 431, pl. 17, fig. 6.

Polymorphina lactea var. *concava* SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 51, No. 9, 1907, p. 14, pl. 3, figs. 8, 9.

Variety differing from the typical in the attached character. It holds to the short form seen in the early stages of *G. lactea.*

Distribution.—From the records the variety has been found Recent in the Mediterranean, in the Pliocene (Crag) of Sutton, England, and at Selsey, England.

GUTTULINA SCHAFFERI Cushman and Ozawa, new species

Plate 11, figures 1 *a–c*

Test oval, but little compressed; chambers more or less longer than wide, arranged in a nearly quinqueloculine series, each succeeding chamber removed from the base; sutures but little depressed, not very distinct; wall ornamented by rather strong, uniformly distributed spines; aperture radiate.

Length of holotype 0.65 mm.; breadth 0.42 mm.; thickness 0.25 mm.

Holotype.—(Cushman Coll. No. 11259.) From the Miocene, Tortonian, *Amphistegina* marl of Grunes Kreuz, Nussdorf, near Vienna, Austria. (Paratypes, Geological Institute, Imperial University of Tokyo, Japan.)

The shape of the test and the arrangement of chambers of the present species are very similar to *Guttulina deformata,* but the chambers are more slender and the surface is uniformly ornamented by blunt spines. The specific name is given for Prof. F. X. Schaffer, Director of the Geological and Paleontological Department of the Museum of Natural History in Vienna.

Distribution.—Specimens were collected from the *Amphistegina* marl at Grunes Kreuz in the Vienna Basin.

GUTTULINA WOODSI Cushman and Ozawa, new species

Plate 11, figures 2 *a–c*

Test fusiform, greatest breadth slightly above the middle; chambers rather inflated, not much longer than broad, embracing, arranged in a nearly quinqueloculine series, each succeeding chamber farther removed from the base; sutures but little depressed, distinct; wall rather thin, smooth; aperture produced, radiate.

Length 0.35 mm.; breadth 0.15 mm.; thickness 0.15 mm.

Holotype.—(Cushman Coll. No. 11260.) From the Cretaceous, lower Gault, of Barnwell Pit, Cambridge, England.

Guttulina woodsi resembles the Cretaceous *Guttulina elliptica*, described from Bohemia by Reuss, in its general outline, but Reuss's species is more or less compressed and the chambers are shorter. We have some doubts about the arrangement of chambers of Reuss's species.

The specific name is given for Doctor Woods of the Sedgwick Museum of Cambridge, England.

GUTTULINA QUINQUECOSTA Cushman and Ozawa

Plate 11, figures 3 *a–c*

Guttulina quinquecosta CUSHMAN and OZAWA, MS. in Cushman and Valentine, Contrib. Dept. Geol., Stanford Univ., vol. 1, 1930, p. 19, pl. 5, figs. 6*a–c*.

Test oblong, greatest breadth above the middle, regularly tapering toward the base which ends in a spine; chambers inflated, slightly longer than broad, not much embracing, arranged in a quinqueloculine series, each succeeding chamber removed farther from the base; sutures depressed, generally distinct, especially those of the later chambers; wall thick, smooth, ornamented at its basal portion with five more or less strong costae starting from the caudal spine radiating in five directions in accordance with the quinqueloculine arrangement of chambers; aperture slightly produced, radiate.

Length 0.40–0.90 mm.; breadth 0.25–0.50 mm.; thickness 0.20–0.40 mm.

Holotype.—(Cushman Coll. No. 11930.) From off the Channel Islands, Calif.

In its general outline it is similar to *Guttulina yabei*, but it is smaller and invariably ornamented by five costae at its basal portion, as in the case of *Guttulina costatula*, which is an entirely ornamented and much smaller species.

Distribution.—It seems to be limited to the California coast, where it occurs in the Pliocene and Pleistocene and also as a Recent species.

GUTTULINA PAALZOWI Cushman and Ozawa, new species

Plate 11, figures 4 *a*, *b*

Test elongate fusiform, obtuse at the initial end, acute at the apertural end; chambers elongated but little inflated, much embracing, arranged in a quinqueloculine series, each succeeding chamber farther removed from the base; sutures but little depressed, often obscure; wall thick, smooth; aperture radiate.

Length 1.40–1.70 mm.; breadth 0.50–0.55 mm.; thickness 0.40–0.45 mm.

Holotype.—(Cushman Coll. No. 11265.) From the Upper Cretaceous of Maastricht, Holland.

The present species is one of the most elongated and slender forms of *Guttulina*, and is comparable in its general outline to *Pyrulina*, but its chambers are arranged in a nearly quinqueloculine series. It may be considered to be an elongated, specialized form of the Cretaceous *Guttulina woodsi*.

The species is named for Mr. Richard Paalzow, from whom the Cretaceous material of Maastricht was obtained.

Distribution.—It is only known from the Upper Cretaceous material from Maastricht where it is rather common.

GUTTULINA EMERSONI (Bagg)

Plate 11, figure 6

Polymorphina emersoni BAGG, Bull. 88, U. S. Geol. Survey, 1898, p. 60, pl. 6, fig. 3.—WELLER, Geol. Survey New Jersey, Paleontology, vol. 4, 1907, p. 249, pl. 3, fig. 19.

We have no specimens comparable with the present species. Bagg's figure is not enough to give any definite idea of the species, and we can not with certainty determine to what genus it belongs. It is probably a *Guttulina*. If it is, it may be a young specimen having two chambers or possibly three. Bagg's description runs as follows:

"Test elongate oval, oral end acute, posterior obtusely rounded; surface of test covered completely by fine longitudinal costae; chambers two, elongated, oblique, separated by nearly straight septa slightly marked near the posterior end, depressed at the peripheral margin; aperture rotund."

The type locality is from the Cretaceous, Monmouth formation, Freehold, N. J., recorded as very rare.

GUTTULINA DAWSONI Cushman and Ozawa, new species

Plate 12, figures 1, 2

Test elongated, the greatest breadth in the upper half, uniformly tapering to the base; chambers elongated, more than three times as long as wide, not much embracing, arranged in a contraclockwise, quinqueloculine series, each succeeding chamber much farther removed from the base; sutures slightly depressed, distinct; wall rather thin, smooth; aperture radiate.

Normal forms, length 0.90–1.00 mm.; breadth 0.33–0.38 mm.; thickness 0.30–0.35 mm.

Holotype.—(Cushman Coll. No. 11267.) From Gaspé Bay, Province of Quebec, Canada.

We also have specimens from Hudson Bay, bay on east coast, south of Black Whale Harbor.

The present elongated species is somewhat similar to *Guttulina paalzowi* from the Upper Cretaceous of Maastricht in the general

appearance, but its chambers are arranged in a contraclockwise series instead of a clockwise series, as in *G. paalzowi*. Moreover, its test has the greatest breadth in the upper half, while *G. paalzowi* is elongated fusiform.

The species is named for G. M. Dawson, one of the early workers on American foraminifera.

GUTTULINA COSTULATA (Cushman)

Plate 12, figures 3 *a*, *b*

Polymorphina cuspidata H. B. Brady var. *costulata* Cushman, U. S. Geol. Survey Prof. Paper 129–F, 1922, p. 133, pl. 31, fig. 1; Prof. Paper 133, 1923, p. 32.

Test elongate, fusiform, a strong spine at the base; chambers elongated, inflated, not much embracing, arranged in a quinqueloculine series, each succeeding chamber removed farther from the base; sutures depressed, distinct; wall ornamented by strong, continuous, bladelike costae rather widely separated from each other; aperture radiate.

Length of holotype 0.70 mm.; breadth 0.20 mm.

The present species is one of the most clearly marked species of *Guttulina*. In its general outline, it resembles *Guttulina pulchella* d'Orbigny from which it is easily distinguished by its strong bladelike costae entirely covering the test and a large spine at the base.

Distribution.—Cushman reported it from the lower Oligocene, Mint Spring marl, Mint Spring Bayou, Vicksburg, Miss. Specimens which seem identical occur in the lower Pliocene of Beaumaris, near Melbourne, Victoria, Australia.

As it occurs slightly earlier in the fossil series, this may be the ancestral form of *Pseudopolymorphina rutila*, which in its earlier stages is *Guttulina*-like, but later becomes definitely a *Pseudopolymorphina*. This is another of the interesting species connecting the lower Oligocene of the United States with the late Tertiary and Recent faunas of the Australian region.

GUTTULINA SEMICOSTATA (Marsson)

Plate 15, figures 8 *a–c*

Polymorphina semicostata Marsson, Mitth. Nat. Ver. Neu-Vorpommern. u. Rügen, Jahrg. 10, 1878, p. 150, pl. 2, figs. 19 *a–c*.—Franke, Abhandl. geol. pal. Instit. Univ. Greifswald, vol. 6, 1925, p. 78, pl. 6, fig. 21.

Polymorphina var. Wright, Proc. Belfast Nat. Field Club, Appendix, 1885–86, p. 331, pl. 27, figs. 13, 14.—Jones and Chapman, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 509, fig. 3 (in text).

Test globular, broadest above the middle, more or less obtuse at the initial end; chambers rounded, much inflated, but little embracing, arranged in a quinqueloculine series, each succeeding chamber

removed farther from the base; sutures much depressed, distinct; wall partly ornamented by longitudinal costae independent of the sutures; aperture radiate.

Polymorphina semicostata was first described by Marsson from the uppermost Cretaceous of Rügen. His figures are apparently well drawn, but seem to us not to give fully the details of the species, especially as the arrangement of chambers is not drawn in sufficient detail. Franke quite recently figured Marsson's specimen. His figure shows a nearly quinqueloculine arrangement of chambers characteristic of *Guttulina*. Wright figures similar specimens from the Cretaceous of Keady Hill, County Derry, Ireland. We have some material from the Cretaceous of Rügen, but could not find any specimen like the present one, and accordingly Marsson's figures are reproduced in the present paper.

Distribution.—Only known from the Upper Cretaceous (upper Senonian) of Rügen; very rare.

GUTTULINA SADOENSIS (Cushman and Ozawa)

Plate 37, figures 1, 2

Sigmomorpha sadoensis CUSHMAN and OZAWA, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 17, pl. 2, fig. 11; Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 73, pl. 13, figs. 9–11; pl. 16, figs. 2–4.

Test more or less rhomboid, greatest breadth usually below the middle, generally triangular in end view; chambers numerous, elongate, two to three times as long as broad, varying considerably in the amount of overlapping, some of the specimens with the chambers almost extending down to the base, others with the chambers considerably above the base and the last-formed chamber in the adult often not reaching back more than halfway to the base of the test; chambers arranged in a quinqueloculine series, often becoming sigmoidal; sutures depressed, distinct; wall thick but translucent, smooth; aperture radiate.

Length of holotype 0.83 mm.; breadth 0.50 mm.; thickness 0.36 mm.

The present species has rather slender, clavate chambers arranged in a quinqueloculine series, which in later stages often tends to become sigmoidal. We took the present species as the genotype of *Sigmomorpha*, but we think it better to include it in *Guttulina*. It is an intermediate form between *Guttulina* and *Sigmomorphina*.

Distribution.—It is only known from the Pliocene of Japan, at Sawané, Island of Sado in the Sea of Japan, where it is very abundant.

GUTTULINA (SIGMOIDINA) PACIFICA (Cushman and Ozawa)

Plate 37, figures 3–5

Sigmoidella (*Sigmoidina*) *pacifica* CUSHMAN and OZAWA, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 19, pl. 2, fig. 13; Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 77, pl. 16, figs. 12, 13.

Polymorphina elegantissima CHAPMAN (not H. B. Brady, Parker, and Jones), New Zealand Geol. Surv., Pal. Bull. No. 11, 1926, p. 67, pl. 13, fig. 10.

Test ovate, the greatest breadth below the middle, acuminate toward the aperture; chambers elongated, more or less inflated, arranged in either clockwise or contraclockwise, quinqueloculine series, earlier chambers invisible from the exterior, each succeeding chamber involves the earlier one; suture depressed, distinct; wall smooth, rather thick; aperture radiate.

Measurements of the holotype specimen as follows: Length 0.76 mm.; breadth 0.53 mm.; thickness 0.31 mm.

Holotype.—(Cat. No. 20313, U.S.N.M.) From *Albatross* D5318, China Sea near Formosa, 340 fathoms.

Distribution.—We also have specimens from the following:

Recent.—*Albatross* D5315, China Sea near Formosa, 148 fathoms; from off Kobama, Sea of Japan; from off Terao Miura, Japan; off Poor Knight's Islands, New Zealand, 60 fathoms; off the Snares, New Zealand.

Miocene.—Chuthulin, Batesford, Victoria, Australia.

GUTTULINA (SIGMOIDINA) SEGUENZANA (H. B. Brady)

Plate 37, figures 8, 9

Polymorphina seguenzana H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 567, pl. 72, figs. 16, 17.

Test elongate, fusiform, compressed on three sides; broadest somewhat below the center, tapering gradually toward the apertural end and somewhat more rapidly toward the opposite extremity, which finishes in a sharp point; segments few in number, only three visible externally, long, narrow, erect; surface smooth, sutures marked by fine lines without external depressions.

Length 1.6 mm.

The trifacial compression of the test, its acuminate initial end, and the erect position of the segments are sufficient to distinguish the species from its near allies.

This is an unusual species among the Polymorphinidae. It appears to have a triserial arrangement of chambers like *Triloculina*, but both ends are acute. The above description is from Brady.

Distribution.—Very rare off the Ki Islands, southwest of New Guinea, 129 fathoms; Port Jackson, New South Wales, 2–10 fathoms.

GUTTULINA (SIGMOIDINA) SILVESTRII Cushman and Ozawa, new species

Plate 37, figures 6, 7

Test almost circular in outline, much inflated in the central part, periphery more or less angular; chambers elongated, arranged in either clockwise or contraclockwise, quinqueloculine series, involute, extra chamber short, inflated, not extending down to the base; sutures very little depressed, distinct; wall smooth, rather thick; aperture radiate.

Length 0.60–1.25 mm.; breadth 0.60–1.05 mm.; thickness 0.40–0.65 mm.

Holotype.—(Cushman Coll. No. 9863.) From the Miocene (Janjukian), Filter quarry, Batesford, near Victoria, Australia.

It differs from *Sigmoidina pacifica* in its circular test, more angulate peripheries and very slightly depressed sutures. It may be specially noted here that when the present species has an extra chamber the chamber is added in the same series as the arrangement of the earlier ones, although it is much shorter and does not extend down to the base. (See pl. 37, fig. 7*a*.) From this fact it is easily understood that the species is not a young stage of *Sigmoidella elegantissima*.

Guttulina disciformis, reported by Terquem from the Pliocene of the Isle of Rhodes, is very similar to the present species and may represent either a young stage or the megalospheric form of the species, but it has a rounded periphery, and it may be possible that the specimen is the young of some other species, such as *Sigmoidella elegantissima*, which we found in the Miocene of Pontlevoy, France. Therefore we do not like to place these specimens under such an ambiguous species as *G. disciformis*.

The species is named for Prof. A. Silvestri of Milan.

Distribution.—Recent from Australia, New Zealand and the Philippines; fossil in the Miocene of Australia. We have specimens from the following localities:

Recent.—Australia, Wool Bay, Yorkes Peninsula, west side of St. Vincent Gulf, South Australia; Hardwick Bay, east side of Spencer Gulf; New Zealand, Oamaru, 50 fathoms; off the Big King, 98 fathoms.

Miocene.—Australia, Janjukian, Filter quarries, Batesford, Victoria.

Genus PYRULINA d'Orbigny, 1826

PYRULINA GUTTA d'Orbigny

Plate 13, figures 1 *a–c*

Pyrulina gutta D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 28, model 30.—OZAWA, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 39, pl. 6, figs. 4, 5.

Polymorphina gutta H. B. BRADY, PARKER, and JONES (not d'Orbigny), Trans. Linn. Soc., vol. 27, 1870, p. 218, pl. 39, figs. 3*a*, *b*.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., ser. 2, vol. 6, 1886, p. 755, pl. 16, fig. 6[?].

Polymorphina clavata ROEMER, Neues Jahrb. f. Min., etc., 1838, p. 386, pl. 3, fig. 38.

Polymorphina amygdaloides CUSHMAN (not Reuss), U. S. Geol. Survey Prof. Paper 133, 1923, p. 32, pl. 4, fig. 9.

Test clavate, rounded at the base, tapering toward the apertural end, margin entire; chambers rounded, embracing, arranged at first in an almost triserial series, later tending to become biserial; sutures not depressed, distinct; wall smooth; aperture radiate, pointed.

Length 0.50–0.60 mm.; breadth 0.18–0.25 mm.; thickness 0.18–0.25 mm.

The original specimen (in paleontological department, Museum of Natural History, Jardin des Plantes, Paris) is lost.

D'Orbigny's figures represent the species fairly well, although his basal view showing the arrangement of chambers is not well drawn as far as the figure of the side view is concerned. D'Orbigny's specimen was obtained from the Pliocene at Castel-Arquato. We have examined material from the same locality, but we could not obtain any specimen resembling his species. The specimen figured here was found in the Eocene material from Wansin in Belgium, and the specimen is very much like d'Orbigny's model in every respect. Our specimen presents an arrangement of chambers not strictly triserial, at first somewhat triserial, but later tending to become biserial. As d'Orbigny's original specimen is lost and his figure of the basal view apparently is not well drawn, the figure showing the side view is the only means of knowing how the chambers of d'Orbigny's specimen are arranged. Judging from his figure, at least the later chambers of his species appear to be arranged in an almost biserial series, which seems to be the usual arrangement in a group of elongate, cylindrical Polymorphinidae.

D'Orbigny compared his species with Soldani's *Polymorphium pyriformium* figured in the Testaceographia. Soldani's specimen resembles *Pyrulina gutta* in its shape, but judging from the figure it seems to have fewer chambers, and it may be considered to a be a young stage of *Pyrulina gutta*, but it is characterized by a peculiar sigmoid suture, in which point it is quite distinct, and therefore it is advisable not to place it in the synonymy of *P. gutta*.

On the other hand, *Polymorphina* (*Globulina*) *clavata* figured by Roemer from the German middle Oligocene, considered from his figure, very closely resembles *Pyrulina gutta*.

We have additional specimens from the Eocene of France, Lutetien of Grignon, Chaussy and Courtagnon; also from the Eocene, Bracklesham beds XVII and XVIII, White Cliff Bay, Isle of Wight, England.

PYRULINA LABIATA (Schwager)

Plate 12, figures 4 *a*, *b*

Polymorphina labiata SCHWAGER, *Novara*-Exped., Geol. Theil, vol. 2, 1866, p. 246, pl. 7, fig. 90.

Test elongated, acute at both ends; chambers elongated, overlapping, arranged in a nearly triserial series from the beginning to the end, growth rapid; sutures not depressed, not distinct; wall smooth, rather thin; aperture radiate.

Length, 0.75–0.80 mm.; breadth, 0.30–0.33 mm.; thickness, 0.30–0.33 mm.

Pyrulina labiata in its general feature resembles *P. cylindroides*, but its chambers are arranged in a triserial series even in the later stages, and the chambers are slightly shorter than those of the latter species. Schwager's figure of the species does not clearly show the arrangement of chambers, especially that of the early stage.

Distribution.—Schwager recorded the present species from the Pliocene, upper clay of Kar Nicobar. We have specimens from the Pliocene of Fiji.

PYRULINA VICKSBURGENSIS (Cushman)

Plate 13, figures 2 *a–c*

Polymorphina vicksburgensis CUSHMAN, U. S. Geol. Survey, Prof. Paper 129–F, 1922, p. 133, pl. 31, fig. 2; Prof. Paper 133, 1923, p. 33.

Test elongate, fusiform, broadest near the initial end, which is subcircular in transverse section, the later portion becoming compressed and narrower, initial end bluntly pointed, or with a short spine; chambers becoming shorter toward the apertural end in the adult and arranged in an almost biserial series; surface smooth or with very slight longitudinal costae; sutures not depressed but often standing out as clearer areas in side view; aperture radiate.

Length, 1.50 mm. or less; breadth, 0.40 mm.

Type specimen from Station 6451, Mint Spring Bayou, Vicksburg, Miss. This species occurs also at Station 6448, Glass Bayou, Vicksburg, Miss.

This seems to be different from the other described species of this genus, and may be distinguished especially by the cuspidate initial end and the peculiar change in shape from the rounded early portion to the narrow, compressed last-formed portion.

PYRULINA EXTENSA (Cushman)

Plate 12, figures 5 *a–c*

Polymorphina longicollis H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 572, pl. 73, figs. 18, 19.—EGGER, Abhandl. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 310, pl. 9, fig. 21.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 90, pl. 41, figs. 1–3.

Polymorphina extensa CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 90, pl. 41, figs. 1–3; Bull. 104, pt. 4, 1923, p. 156, pl. 41, figs. 7, 8.

Test elongate, fusiform, margin almost entire, initial end more or less pointed, apertural end produced into an elongate, cylindrical neck; chambers not numerous, inflated; sutures fairly distinct, but not depressed, except in the case of the last-formed one; wall more or less hispid, the last chamber especially more inflated and spinose and often covered with fistulose tubes; aperture a long neck, not radiate.

Length, 0.50–0.85 mm.; breadth, 0.22–0.28 mm.; thickness, 0.22–0.28 mm.

The present species is very unique in its long produced neck and lip, which are similar to those of *Uvigerina*, but the other characters are undoubtedly those of *Pyrulina*.

Distribution.—It is known as a Recent species and seems to be mostly limited to the deep sea. Brady figures an excellent specimen from the South Atlantic from *Challenger* 388, in 1,990 fathoms (3,640 meters), and records it also from the South Pacific. We have Recent specimens from the Atlantic off the eastern coast of the United States from *Albatross* D2035 in 1,362 fathoms, D2105 in 1,395 fathoms, and D2562 in 1,434 fathoms. There are also specimens with hispid exterior from the Tertiary of Trinidad, from South of Hospital Hill, San Fernando, collected by P. W. Jarvis which are very close to Recent specimens. We have also a single smooth specimen with an elongated neck similar to this species from the middle Oligocene of Hermsdorf near Berlin, which should be noted in connection with this species. More specimens are needed to definitely place it. It also occurs in the Pliocene of Fiji, a series of sediments deposited in fairly deep water.

PYRULINA FUSIFORMIS (Roemer)

Plate 13, figures 3–8

Polymorphina fusiformis Roemer, Neues Jahrb. für Min., etc., 1838, p. 386, pl. 3, fig. 37.—H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 219, pl. 39, figs. 5 *b*, *c*; and Woodcut *e*.—Jones and Chapman, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 511, fig. 15 (in text).

Guttulina cylindrica Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 347, pl. 18, figs. 4–6.

Polymorphina cylindroides Reuss (not Roemer), Sitz. Akad. Wiss. Wien, vol. 18, 1855(1856), p. 249, pl. 8, fig. 78.

Guttulina ovalis Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 345, pl. 17, fig. 7.—Cushman, Bull. Soc. Sci. Seine-et-Oise, ser. 2, vol. 9, 1928, p. 50, pl. 1, fig. 7 *a*, *b*.

Polymorphina subteres Reuss, Sitz. Akad. Wiss. Wien, vol. 42, 1860, p. 361, pl. 2, fig. 14.

Pyrulina obtusa Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 79, pl. 9, fig. 9.

Polymorphina lanceolata Reuss, Sitz. Akad. Wiss. Wien, vol. 48, pt. 1, 1863, p. 58, pl. 7, figs. 75, 79–84 (not figs. 76–78); vol. 62, pt. 1, 1870, p. 487.—v. Schlicht, Foram. Septar. Pietzpuhl, 1870, only pl. 31, figs. 1, 2, 5–8,

17–20, 25–27.—Hosius (not Reuss), Ver. Nat. Hist. Vereins Pr. Rheinlande, vol. 50, 1893, p. 107, pl. 2, fig. 7.—Jones and Chapman, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 510, figs. 11, 12 (in text).—Paalzow, Ber. Offenb. Ver. Nat., 1912, p. 68, pl. 1, figs. 11, 12.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 86, pl. 40, fig. 2.—Franke, Danmarks Geol. Unders. 2, Raekke, No. 46, 1927, p. 36, pl. 3, fig. 12.

Polymorphina (*Guttulina*) *lanceolata* Andreae, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, pt. 3, 1884, pp. 118, 141, pl. 9, figs. 18–20.

Polymorphina tenera Karrer, Sitz. Akad. Wiss. Wien, vol. 58, abt. 1, 1868, p. 174, pl. 4, fig. 9.

Polymorphina sororia var. *cuspidata* Chapman (not H. B. Brady), Journ. Roy. Micr. Soc., 1896, p. 13, pl. 2, fig. 13.

Polymorphina ampla Cushman (not Karrer), Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 603, pl. 20, fig, 6.

Polymorphina angusta H. B. Brady (not Egger), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 563, pl. 71, figs. 17–19; pl. 72, fig. 4.—Chapman and Parr, Journ. Linn. Soc. Zool., vol. 36, 1926, p. 392, pl. 21, fig. 75.

Test fusiform to cylindrical, acute at both ends, often with a spine at the initial end, almost circular in end view; chambers rather short, not much embracing, arranged at first in a nearly triserial series, later becoming biserial; sutures not depressed, generally distinct; wall smooth; aperture radiate.

Length 0.55–1.25 mm.; breadth 0.20–0.50 mm.; thickness 0.20–0.50 mm.

There are many specific names given to this cylindrical member of the genus, having the chambers rather short and not much embracing. Of these names, that of Roemer's appears to be the earliest. Roemer's figure, as nearly as can be made out and considered from our study of many topotypes obtained from Cassel, seems to represent a rather young stage, having but few chambers. *Pyrulina fusiformis* is quite distinct from *Pyrulina cylindroides* which has long fusiform chambers.

Among the figures of *Guttulina cylindrica* given by Bornemann, Figures 4 and 5 are fair representatives of the present species, and Figure 6 is considered to be an adult specimen. *Guttulina ovalis* Bornemann is closely related to *Globulina minima* but it has more chambers regularly arranged, and it seems better to place it in the synonymy of the present species.

Reuss's *Polymorphina lanceolata*, figured in 1863 (excepting figures 76, 77), and *Polymorphina subteres* coincide in their every feature with *Pyrulina fusiformis*.

Polymorphina tenera Karrer having a rounded initial end, and *Polymorphina sororia* var. *cuspidata* H. B. Brady, with an initial spine, are considered to be included in the range of variation of the present species.

Distribution.—Rather common in various Tertiary deposits in Europe and widely distributed geographically in the Recent oceans. Our specimens are obtained from the following localities:

Recent.—Atlantic, *Albatross* D2035, 1,362 fathoms; D2038, 2,033 fathoms; D2042, 1,555 fathoms; D2109, 142 fathoms; D2174, 1,594 fathoms; D2228, 1,582 fathoms; D2677, 478 fathoms; D2678, 731 fathoms, all off the eastern coast of the United States; D2160, 167 fathoms off Cuba. Pacific, *Nero* Stations 170, 1,990 fathoms; 1287, 1,606 fathoms; 1,299, 1,817 fathoms; 1300, 1,529 fathoms; 1312, 1,552 fathoms; 1316, 1,649 fathoms; 1324, 1,915 fathoms. There are specimens also from off Alaska.

Pleistocene.—Leda Clay, Province of Quebec, Canada.

Miocene.—Hungary, Kostej, Banat. Austria, Baden, Vienna Basin.

Oligocene.—Germany, Ahnatal, near Cassel; Hermsdorf, near Berlin; Pietzpuhl; Hildesheimer Wald, Dickholzen, Hannover; Lobsann; Doberg, near Bünde.

PYRULINA CYLINDROIDES (Roemer)

Plate 14, figures 1–5

Polymorphina cylindroides Roemer, Neues Jahrb. f. Min., etc., 1838, p. 385, pl. 3, fig. 26.—H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 221, pl. 39, figs. 6 *a*, *b*, *c*.

Polymorphina fusiformis Cushman (not Roemer), Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 604, pl. 20, fig. 14.

Test elongate, fusiform to cylindrical, acuminate toward both extremities, almost circular in cross section; chambers elongate, not much embracing, arranged in a nearly triserial series, tending to become biserial, each succeeding chamber farther removed from the base; sutures but little depressed; wall smooth; aperture radiate.

Length 0.50–1.10 mm.; breadth 0.18–0.32 mm.; thickness 0.15–0.30 mm.

As Roemer's figures of the present species are rather obscure, owing to their small size and poor execution, we have endeavored to get a specimen which is most nearly like his figures among our abundant specimens from the German Oligocene of various localities. The specimen figured in the plate is considered by us as typical of Roemer's *Polymorphina cylindroides*, and the above description is written in accordance with our specimen. *Pyrulina cylindroides* of our diagnosis was generally identified with *Polymorphina fusiformis*, from which it is easily separable by its elongate chambers.

Cretaceous *Pyrulina porrecta* Reuss is almost impossible to distinguish from the present species, and as far as the material examined is concerned there is no distinction between them. From Cretaceous *Pyrulina acuminata* it is easily separated by its elongate chambers but little embracing.

Distribution.—The present species is widely distributed in various Cretaceous deposits both in Europe and America. In the Tertiary and Recent, it is not as common as in the Cretaceous, and these may finally be recognized as distinct. The localities of our specimens are as follows:

Recent.—*Albatross* stations off the east coast of the United States and Brazil (rare specimens of the same general form as this species).

Pliocene.—Belgium, Crag noir, Antwerp (very rare specimens which may be referred to this species at present).

Miocene.—"Green clay," Cipero section, Trinidad (a single specimen referred to this species).

Oligocene.—Germany, Ahnatal, near Cassel; Hermsdorf, near Berlin; Söllingen; Düsseldorf.

Eocene.—South of Hospital Hill, San Fernando, Trinidad, British West Indies.

Cretaceous.—England, Chalkmarl, Folkestone; Saxon Cement Works, Cambridge; Cambridge Greensand, Saxon Cement Works, Cambridge; Gault, Folkestone; Barnwell Pit, Cambridge. Germany, upper Senonian, Dasbeck, near Hanover, Westphalia; Turonian, Birkwitz, near Pirna. Mexico, Velasco Shale, Hacienda El Limon, near Panuco.

PYRULINA THOUINI (d'Orbigny)

Plate 14, figures 6*a–c*

Polymorphina thouini D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 8; model No. 23.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 232, pl. 40, fig. 17.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 59, pl. 10, figs. 557–558.

Test attenuate, subcylindrical, almost circular in end view; chambers elongate, not much embracing, arranged at first in a nearly triserial series becoming biserial later, each succeeding chamber removed much farther from the base; sutures slightly depressed, distinct; wall smooth, translucent; aperture radiate.

Length 0.65–0.95 mm.; breadth 0.20–0.25 mm.; thickness 0.18–0.25 mm.

Pyrulina thouini is one of the best defined species of *Pyrulina*, and is closely related to the widely distributed *Pyrulina cylindroides*, from which it may be derived by drawing out the slender fusiform chambers which are placed less obliquely, and accordingly the test becomes more elongate. Terquem's *Polymorphina thouini* from Vaudancourt somewhat resembles d'Orbigny's species, but we should hesitate to place it under the synonymy of the present species, as it has much depressed sutures.

We have examined material from the Paris Basin, and obtained some excellent specimens coinciding well with the model of d'Orbigny. The original specimen is lost.

Distribution.—We have specimens in our collection from the Eocene of France from Grignon and Damery.

PYRULINA ACUMINATA d'Orbigny

Plate 14, figures 7 *a–c*

Pyrulina acuminata D'ORBIGNY, Mém. Soc. Géol. France, 1840, p. 43, pl 4, figs. 18, 19.—REUSS, in Geinitz, Grundr. Verstein., 1845–46, p. 670, pl. 24, fig. 64.—D'ORBIGNY, Prodrome de Paleont., vol. 2, 1850, p. 282, No. 1405.—REUSS, Haidinger's Nat. Abhandl., vol. 4, 1851, p. 26.—BEISSEL, Abhandl. kön. Preuss. geol. Landes., n. ser., vol. 3, 1891, p. 63, pl. 10, figs. 54–59.

Pyrulina ovulum EHRENBERG, Mikrogeologie, 1854, pl. 31, figs. 35, 36.

Polymorphina acuminata H. B. BRADY, PARKER, and JONES (not d'Orbigny), Trans. Linn. Soc., vol. 27, 1870, p. 219, pl. 39, figs. 4 *a*, *b*.—EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 130, pl. 17, fig. 3.

Polymorphina (*Pyrula*) *acuminata* EGGER, Ber. nat. Ver. Passau, 1907, p. 40, pl. 4, fig. 27.

Test ovate-elongate to fusiform, both ends acuminate; chambers inflated, much embracing, arranged in a nearly triserial series in the early stages, becoming biserial later; sutures not depressed, difficult to recognize; wall smooth; aperture produced, radiate.

Length 0.80–1.30 mm.; breadth 0.28–0.50 mm.; thickness 0.25–0.50 mm.

In some of its characters, *Pyrulina acuminata* bears some resemblance to *Pyrulina porrecta*, but the latter has generally a much more slender test, the chambers scarcely overlapping, and is not as compactly built as is the present species. Both extremities are strongly acuminate, a very characteristic feature of the species.

Distribution.—Not rare in Cretaceous deposits, but very rare in the earlier Tertiary. We have specimens of *Pyrulina acuminata* from the following localities: France, Upper Cretaceous, Chalk, Bougival. Germany, Upper Senonian, Rinkerode and Dasbeck, both in Westphalia. We have a series of specimens from the lower Tertiary of San Fernando, Trinidad, British West Indies, collected by P. W. Jarvis, which seem identical with this species. The series contains slightly compressed as well as normal specimens and several that are fistulose.

PYRULINA ALBATROSSI Cushman and Ozawa, new species

Plate 15, figures 1–3

Test elongate, fusiform to cylindrical, acute at both ends; chambers elongated, much embracing, arranged in a triserial series, becoming biserial later, but often one extra, rounded chamber added at the top of the test, each succeeding chamber slightly removed from the base; sutures but little depressed, nearly vertical, generally distinct; wall smooth, thin, almost transparent; aperture radiate.

Holotype, length 1.85 mm.; breadth 0.65 mm.; thickness 0.40 mm.

Holotype.—(Cat. No. 20952, U.S.N.M.) From *Albatross* D2160, 167 fathoms off Cuba.

In its general appearance it closely resembles *Pyrulina cylindroides*, but most of its sutures are almost vertical instead of oblique. It has often one extra chamber added at the top of the main test. In such a case, the suture of this extra chamber can not be distinguished from the others because of its similar appearance.

Distribution.—In addition to the type locality, we have specimens from *Albatross* D2756, 417 fathoms, coast of Brazil, and D2105, 1,395 fathoms, east coast of United States. There is a specimen also from *Nero* 613 in the Pacific that is close to the present species.

PYRULINA RETICULOSA Cushman and Ozawa

Plate 15, figures 4 *a*, *b*

Pyrulina reticulosa CUSHMAN and OZAWA, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 69, pl. 15, fig. 1.

Test elongate, elliptical, irregular in form, nearly circular in transverse section; chambers few, apparently three in the type specimen; sutures obscured by the ornamentation which consists of generally longitudinal costae with transverse ones between, making an irregular reticulation; aperture radiate.

Length 0.70 mm.; breadth 0.33 mm.

Holotype.—(Cat. No. 20312, U.S.N.M.) From *Albatross* D4882, Blake Reef off Vagadosaki Lighthouse, 248 fathoms.

This species is unique in its ornamentation. It may represent an intermediate between *Globulina* and *Pyrulina*.

PYRULINA VELASCOENSIS (Cushman)

Plate 29, figures 1 *a–c*

Polymorphina velascoensis CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 604, pl. 20, figs. 16 *a*, *b*.

Test elongate, fusiform in front view, in side view with the sides unequal, one side convex, the other concave, the concave side in front view with a central depression; chambers not elongated, rather compressed, arranged in a biserial series; sutures not at all depressed, very indistinct; wall smooth; aperture radiate.

Length 0.70 mm.; breadth 0.25 mm.; thickness 0.18 mm.

This is a very peculiarly curved species having a longitudinal central depression.

Distribution.—This species is from the Velasco shale of the Tampico embayment, Mexico.

Genus GLOBULINA d'Orbigny, 1826

GLOBULINA GIBBA d'Orbigny

Plate 16, figures 1–4

Globulina gibba d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 10, Modèles No. 63; Foram. Foss. Bass. Tert. Vienne, 1846, p. 227, pl. 13, figs. 13, 14.—Terquem, Essai Class. Anim. Dunkerque, 1875, p. 38, pl. 5, fig. 15; Mém. Soc. Géol. France., sér 3, vol. 1, 1878, p. 43, pl. 4 (9), figs. 1–5; vol. 2, 1882, p. 130, pl. 13 (21), figs. 22–27.—Jones and Chapman, Journ. Linn. Soc. Zool., vol. 25, 1896, pp. 509, 515, figs. 6, 7, 40 (in text).

Polymorphina (*Globulina*) *gibba* Egger, Neues Jahrb. für Min., Jahrg. 1857, p. 289, pl. 13, figs. 1–4.—Andreae, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, pt. 3, 1884, pp. 117, 141, pl. IX, figs. 10–12, 13 *a*, *b*.

Polymorphina gibba H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 216, pl. 39, figs. 2 *a*, *b*.—Reuss, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 485.—v. Schlicht, Foram. Septar. Pietzpuhl, 1870, pl. 27, figs. 1–6, 16–18; pl. 26, figs. 31–34.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 561, pl. 71, figs. 12 *a*, *b*.—Sherborn and Chapman, Journ. Roy. Micr. Soc., ser. 2, vol. 6, 1886, p. 755, pl. 16, fig. 5.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 55, pl. 9, figs. 520–526.—Jones, Foram. Crag, pt. 3, 1896, p. 253, pl. 1, figs. 49–51.—Jones and Chapman, Journ. Linn. Soc. Zool., vol. 25, 1896, pp. 513, 514, figs. 31–33 (in text).—Bagg, Maryland Geol. Surv. (Eocene), 1901, p. 248, pl. 63, fig. 12; (Miocene), 1904, p. 477, pl. 133, fig. 4.—Weller, Geol. Surv. New Jersey, Paleontology, vol. 4, 1907, p. 250, pl. 3, fig. 21.—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., No. 9, vol. 51, 1907, p. 10, pl. 2, figs. 15–17.—Paalzow, Ber. Offenb. Ver. Nat., 1912, p. 67, pl. 1, fig. 10.—Cushman, U. S. Geol. Surv. Bull. 676, 1918, pp. 10, 52, pl. 2, fig. 4; pl. 11, fig. 5; Prof. Paper 129–F, 1922, pp. 93, 94, pl. 17, fig. 3; pl. 18, figs. 3 *a*, *b*.—Plummer, Bull. 2644, Univ. Texas, 1927, p. 122, pl. 6, figs. 8 *a*, *b*.—Stadnichenko, Journ. Pal., vol. 1, 1928, p. 230, pl. 38, figs. 20–22.

Guttulina (*Globulina*) *gibba* Cushman, Bull. Soc. Sci. Seine-et-Oise, ser. 2, vol. 9, 1928, p. 50, pl. 1, figs. 4 *a–c*, 5 *a*, *b*. (Separate, p. 4, pl. 1, figs. 4 *a–c*, 5 *a*, b).

Globulina globosa Reuss (not Münster) in Geinitz, Grundr. Verstein., 1845–46, p. 669, pl. 24, fig. 85; Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 318, pl. 3, fig. 3.

Globulina tubulosa d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 228, pl. 13, figs. 15, 16.

Polymorphina (*Globulina*) *gibba* d'Orbigny var. *ovoidea* Egger, Neues Jahrb. für Min., Jahrg., 1857, p. 289, pl. 13, figs. 5–7.

Polymorphina (*Globulina*) *gibba* d'Orbigny var. *subgibba* Egger, Neues Jahrb. für Min., Jahrg., 1857, p. 289, pl. 13, figs. 8–10.

Polymorphina (*Globulina*) *gibba* d'Orbigny var. *pirula* Egger, Neues Jahrb. für Min., Jahrg., 1857, p. 290, pl. 13, figs. 11, 12.

Globulina amplectens Bornemann (not Reuss), Zeitschr. Deutsch. geol. Ges., vol. 12, 1860, p. 160, pl. 6, figs. 12 *a–c*.

Polymorphina gibba d'Orbigny var. *orbicularis* Karrer, Sitz. Akad. Wiss. Wien, vol. 58, abt. 1, 1868, p. 174, pl. 4, fig. 8.

Globulina subgibba Gümbel, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 10, 1870, p. 645, pl. 2, fig. 79.

Globulina ovalis TERQUEM, Essai Class. Anim. Dunkerque, 1876, p. 77, pl. 10, fig. 2.

Globulina oviformis TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 44, pl. 4 (9), figs. 9–12.

Globulina transversa TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 129, pl. 13 (21), figs. 17–21.

Guttulina ponderosa TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 135, pl. 14 (22), fig. 1 *a*, *b*.

Guttulina gravida TERQUEM and TERQUEM (not Terquem 1878), Bull. Soc. Zool. France, vol. 11, 1886, p. 334, pl. 11, fig. 21.

Polymorphina inflata TERQUEM and TERQUEM (not Terquem 1878), Bull. Soc. Zool. France, vol. 11, 1886, p. 335, pl. 11, fig. 23.

Polymorphina lactea (WALKER and JACOB) var. *diffusa* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 84, pl. 41, fig. 8.

Test globular to subglobular, transverse section almost circular; chambers few, inflated, rounded, arranged in a nearly triserial series; sutures not depressed, generally clear; wall smooth, translucent, often with fistulose tubes, especially at apertural end; aperture radiate.

Length 0.45–1.10 mm.; breadth 0.40–0.90 mm.; thickness 0.40–0.90 mm.

D'Orbigny's original specimen is lost.

Globulina gibba is definite in its general characters; still there are several distinct varieties, and many specific and varietal names are given by various authors to forms which seem merely variations of the typical.

D'Orbigny's model has a globular test, with a slightly produced apex. Egger's *Polymorphina gibba* var. *pyrula* represents a form with a much produced apex, and Gümbel's *Globulina subgibba* is typically spherical, while Karrer's *Polymorphina gibba* var. *orbicularis* has a spheroidal test, shorter than broad.

There are some individuals which can be compared with Egger's *Polymorphina gibba* var. *ovoidea* and *subgibba* and Terquem's *Globulina oviformis*, *transversa*, *ponderosa*, and *inflata*, in which the chambers are either unequally overlapped or not very regularly combined.

There are numerous fistulose forms, some of which are very elaborate and have been given different names, in which the main body of the test is typically *Globulina gibba*.

Distribution.—Globulina gibba is often recorded from the Jurassic and Cretaceous formations, but as far as our material is concerned there are no Mesozoic *Globulina gibba*.

The Cretaceous Globulinas having a more or less globular test are separated from Tertiary *Globulina gibba*, as is described in later pages. We have examined in our collection more than 1,200 specimens of *Globulina gibba*, and the distribution of these is given below. It is very noteworthy that of all these specimens the only Recent ones are from the Mediterranean and off Ireland. In the Pliocene the records are almost entirely from the same region. In the Miocene the dis-

tribution is wide, as it is in the Oligocene and Eocene. Unlike many species of foraminifera, this species died out in the Pacific region and only persisted in the Atlantic and Mediterranean. The opposite is usually the case.

Recent.—Mediterranean, Tripoli; Lido, Venice; 10–14 fathoms, off island of Delos. Southwest of Ireland, dredged by steam tug "*Lord Bandon*," log. 28, 26 fathoms, off Baltimore, Ireland.

Pliocene.—England, Crag, Sutton. Belgium, Crag, Antwerp. Spain, Garrobo. Italy, Castel Arquato; Coroncina, near Siena. Lanarka, island of Cyprus. United States, Shell Creek, De Soto County, Fla.

Miocene.—Austria, Tortonian, Baden; Grunes Kreuz, near Nussdorf; Vosslau; Perchtoldsdorf. Hungary, Tortonian, Varpolata; Kostej; Bujtur, Siebenburgen; Lapugy. France, Helvetian, Pontlevoy; Moulin de Minoy, Salles; Aquitanian superieur, La Brede, Larriey, near Bordeaux; St. Avit; Aquitanian inferieur, La Brede, rauche de Chemin de Fer; Burdigalien superieur, Merignac; Pont Gourguet, Saucats; Burdigalien moyen, Le Coquillat, Leognan; St. Paul de Dax, Dax; Burdigalien inferieur, Moulin de l'Eglise, Saucats. Germany, Ortenberg. Australia, Janjukian, Filter quarry, Batesford, Victoria; green marl, Bird Rock Cliffs, Torquay, Victoria; Danger Point, Torquay, Victoria; Balcombian, Kackeraboite Creek. United States. Duplin marl, Marysville, S. C.; Choctawhatchee marl, 1 mile east of Red Bay, Walton County, Fla.; Chipola marl, Chipola River, Calhoun County, Fla.

Oligocene.—Germany, Upper Oligocene. Ahnatal, near Cassel. Middle Oligocene, Söllingen, Hermsdorf, near Berlin; Wiesloch near Heidelberg; Egisheim. Lower Oligocene, Lattdorf. United States, lower Oligocene, Byram marl, Mississippi; upper fossiliferous zone, 600–700 feet north of bridge over Glass Bayou, Vicksburg; Pearl River at bridge at Byram; Chickasawhay River at wagon bridge, one-fourth mile west of Woodward, 2 miles northwest of Waynesboro; 500 feet west of bridge, 2½ miles south of Waynesboro; road north of National Cemetery, Vicksburg; Leaf River, one-half mile below bridge on Taylorsville-Silvarena Road, near old Blakney post office; calcareous sands, railroad cut east of Brandon; Glendon limestone, Mississippi, below waterfall in Glass Bayou, Vicksburg; Robinson's quarry, 4 miles east of Brandon, Ala.; west bank of Conecuh River at McGowan's bridge, about 1 mile below mouth of Sepulga River; Tiger Hill, east bluff of East Tallahala Creek, sec. 7, T. 1 N., R. 12 E., 10 miles in air line south by east of Bay Springs, Miss.; Marianna limestone, Mississippi, 1½ miles southsoutheast of Heidelberg; 1½ miles northeast of Brandon; Bay Springs, Tallahala Road east of Tallahala Creek; 2½ miles northeast of Calmar post office. Ala. 2½ miles north of Millry; St. Stephens Bluff, right bank of Tombigbee

River, about 9 miles above Jackson; gully west of road from Perdue Hill to Claiborne, 250 feet above Alabama River; east end of wagon bridge on Murder Creek, east of Castleberry; 2½ miles southwest of Whatley; near head of branch about 1 mile east by south of Fail, about 300 yards north of road from Isney to Healing Springs; Mint Spring marl, Mississippi, below waterfall at Glass Bayou, Vicksburg; foot of waterfall in Mint Spring Bayou, Vicksburg; Chickasawhay River, 1¼ miles northwest of mouth of Limestone Creek, 4 miles northwest of Waynesboro; Brown's Cave, east bluff of Leaf River, Smith County; Red Bluff clay, Mississippi, old Red Bluff Landing on Chickasawhay River at Hiwanee, 3½ miles south of Shubuta, Ala.; St. Stephens Bluff, right bank of Tombigbee River, about 9 miles above Jackson, bed 3 of section; near head of small branch about 1 mile southeast of Fail, Ala. Mexico, Huasteca Railroad, between kilometers 9 and 10, 1 kilometer east of Big Cut, Tampico region.

Eocene.—England, Bracklesham bed XVII, White Cliff Bay, Isle of Wight. France, Lutetien, Vaudancourt, Parnes (Les Bôves), Grignon, Courtagnon, Damery, Chaussy, Campbon. Austria, Bartonian, Bruderdorf, bei Stockerau. Italy, Bartonian, Val di Lonte. Germany, Hammer, upper Bavaria. Belgium, lower Eocene, Wansin. Mexico, Guayabal formation, Guayabal. Trinidad, Cipero section. United States, Jacksonian, Alabama; Conecuh River at Beck, Covington County; 3¼ miles north of Grove Hill, on road to Thomasville, Clarke County; road from Perdue Hill to Claiborne, Monroe County; east bank of Sepulga River, about 4 miles northeast of Brooklyn, Conecuh County; Powell's Landing, east bank of Sepugla River, sec. 35, T. 4 N.; R. 13 E., Covington County, road from Bladen Springs to Millry, about 3½ miles southeast of Cullomburg. Mississippi, roadside on hill above pumping station at Jackson; bluff on Garlands Creek, about 5 miles northeast of Shubuta, Quitman County. Florida, Ocala limestone, on road near Blue Springs, 6 miles northeast of Marianna, Jackson County; west bank of Chipola River, at wagon bridge, east of Marianna; quarry of Florida Lime Co., on southwest edge of Ocala, Marion County; phosphate mine, 1½ miles west of Croom, Hernando County. Georgia, 5 miles north of Millen, Jenkins County; east bank of Flint River, at bar three-fourths mile northeast of Atlantic Coast Line Railroad station at Bainbridge; Rich Hill, Crawford County, 6 miles southeast of Roberta. South Carolina, Cooper marl, Ingleside marl pit, Charleston; Mill Creek, Beldock, Barnwell County; steep bluff, west side of Biggin Creek, three-fourths mile below the Coastal Highway, Berkeley County; highway, 17¾ miles west of old Biggin Church, Berkeley County; dump heap from Charleston Aqueduct, 1 mile west of Givhan's Dorchester County.

Claibornian, New Jersey, Vincentown. Alabama, right bank of Tombigbee River at bend about 1 mile above St. Stephens Bluff, Washington County. Midwayan, Tex.

GLOBULINA GIBBA d'Orbigny var. GLOBOSA (v. Münster)

Plate 17, figures 8, 9

Polymorphina globosa v. Münster, in Roemer, Neues Jahrb. f. Min., etc., 1838, p. 386, pl. 3, fig. 33.—Reuss, Die Verstein. böhm. Kreide., 1845, p. 40, pl. 13, fig. 82.—Egger, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 129, pl. 17, fig. 26.

Polymorphina acuta Roemer, Neues Jahrb. f. Min. etc., 1838, p. 386, pl. 3, fig. 36.

Globulina acuta Reuss, Sitz. Akad. Wiss. Wein, vol. 18, 1855 (1856), p. 245, pl. 6, fig. 62.

Globulina aequalis d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 227, pl. 13, figs. 11, 12.

Polymorphina equalis Cushman, U. S. Geol. Survey Prof. Paper 129–F, 1922, p. 132, pl. 31, fig. 3; Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 149, pl. 40, fig. 3.

Polymorphina gibba var. *aequalis* H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 216, pl. 39, figs. 2 *c*, *d*.

Globulina turbinata Terquem, Mém. Soc. Géol. France., sér. 3, vol. 1, 1878, p. 43, pl. 4 (9), figs. 6–8.

Test subglobular to broadly oval, rather convex on one side in the microspheric form, more or less equally compressed in the megalospheric form, slightly produced at the apertural end; chambers more or less compressed, generally up to seven in the microspheric, four in the megalospheric form, the later chambers more embracing on one side, arranged in an almost triserial series, each succeeding chamber more or less above the base; sutures not depressed, distinct; wall smooth, thick, often with fistulose tubes; aperture radiate.

Length 0.65–0.90 mm.; breadth 0.40–0.65 mm.; thickness 0.20–0.35 mm.

This is a compressed modification of *Globulina gibba*, and there is a certain range of variation in its test.

Globulina acuta (Roemer), from the German Oligocene has a rather elongated test with an acuminate apertural end, and in *Globulina turbinata* Terquem the test is rhombic with rounded edges.

Globulina aequalis d'Orbigny, of which both the originals and paratypes were examined by Ozawa, shows a wide range of variation in its shape.

Distribution.—Like *Globulina gibba* and *Globulina inaequalis*, the present variety is widely distributed both geologically and geographically. We have specimens from the following localities:

Recent.—Atlantic off Nymph Bank, South of Cork Harbor, Ireland, 52½ fathoms; Dogs Bay, Ireland; coast of Iceland. Mediterranean, Rimini, Italy. Pacific, shore sand, Torquay, on Bass Strait, Victoria, Australia.

Pliocene.—Belgium, Crag noir, Antwerp. Italy, Castel Arquato.

Miocene.—France, Aquitanian superieur, Mont de Marson, St. Avit; Burdigalien moyen, Le Coquillat, Leognan; Burdigalien inferieur, Moulin de l'Eglise, Saucats. Austria, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna; Perchtoldsdorf, near Vienna; Bujtur, Siebenburgen. Hungary, Tortonian shell sand, Varpolata; Kostej, Banat; Lapugy. United States, Choctawhatchee marl, three-fourths mile east of Red Bay, Walton County, Florida.

Oligocene.—Germany, Ahnatal, near Cassel; Doberg, near Bünde; Flonheim, Mainz Basin; Cothen; Hildesheimer Wald, Dickholzen; Hermsdorf, near Berlin. Mexico, near Cuesta Blanca, Zacamixtle, Vera Cruz.

Eocene.—England, Bracklesham beds, from material washed upon beach at Selsey. Austria, Bartonian, Bruderndorf, near Stockerau. United States, Wilmington, N. C.; Cooper marl, Ashley, Dorchester County, S. C.; Steep Bluff, west side of Biggen Creek, three-fourths mile below Coastal Highway, Berkeley County, S. C.; Vincentown, N. J.

GLOBULINA GIBBA d'Orbigny var. COGNATA (Franzenau)

Plate 19, figures 8 *a–c*

Polymorphina cognata FRANZENAU, Glasnick. Kra. nav. Druztva God., vol. 6, 1894, p. 35, pl. 6, fig. 59.

Variety differing from the typical form in having the spine at the initial end. Length of figured specimen 0.55 mm.; breadth 0.40 mm.; thickness 0.40 mm.

Recent.—Mediterranean, off Island of Delos, 10–14 fathoms.

Pliocene.—Sepik River, Borneo.

GLOBULINA GIBBA d'Orbigny var. STRIATA Egger

Plate 16, figures 5–7

Polymorphina (*Globulina*) *striata* EGGER, Neues Jahrb. für Min., Jahrg. 1857, p. 291, pl. 14, figs. 3, 4.

Polymorphina (*Globulina*) *costata* EGGER, Neues Jahrb. für Min., Jahrg. 1857, p. 291, pl. 14, figs. 5, 6.

Polymorphina costata H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 240, pl. 41, figs. 31 *a, b.*

Variety with the test not compressed, often somewhat longer than broad, wall thick, translucent, ornamentation of the surface consisting of longitudinal, platelike costae, independent of the sutures, each broken into numerous irregular, jagged portions; apertural end usually broadly rounded.

Length 0.30–0.40 mm.; breadth 0.20–0.33 mm.; thickness 0.18–0.30 mm.

We have examined Egger's paratypes of *Polymorphina* (*Globulina*) *striata* and *Polymorphina* (*Globulina*) *costata*, together with other

European Miocene material, and find all gradations between these forms. The platelike costae, broken into numerous irregular, jagged portions are very characteristic of the variety, and by this character *Globulina gibba* var. *striata* can easily be distinguished from the allied forms such as *Globulina gibba* var. *ornata* (Karrer), and var. *myristiformis* (Williamson).

Plate 16, figure 5, is from a paratype of Egger's, and figure 7 is from Ortenburg, Germany.

[GLOBULINA GIBBA d'Orbigny var. MYRISTIFORMIS (Williamson)

Plate 16, figures 8 *a, b;* Plate 20, figures 6 *a, b*

Polymorphina myristiformis WILLIAMSON, Recent Foram. Great Britain, 1858, p. 73, pl. 6, figs. 156–157.—H. B. BRADY, Trans. Linn. Soc. Zool., vol. 24, 1864, p. 473 (table).—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 240, pl. 41, figs. 30 *a–c*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 571, pl. 73, figs. 9, 10.—BALKWILL and MILLETT, Journ. Micr., vol. 3, 1884, p. 16, pl. 4, fig. 10.—BALKWILL and WRIGHT, Trans. Roy. Irish. Acad., vol. 28, Sci., 1885, p. 346.—H. B. BRADY, Journ. Roy. Micr. Soc., 1887, p. 914.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 487.—ROBERTSON, Trans. Nat. Hist. Soc. Glasgow, vol. 3, pt. 3, 1889–92, p. 241.—WRIGHT, Irish Nat., vol. 9, no. 3, 1900, p. 55.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., No. 9, vol. 51, 1907, p. 13, pl. 3, fig. 7.—MILLETT, Recent Foram. Galway, 1908, p. 6, pl. 4, fig. 10.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1909, p. 434; 1911, p. 324; Proc. Roy. Irish Acad., vol. 31, pt. 64, 1913, p. 103, pl. 8, figs. 18, 19; Journ. Roy. Micr. Soc., pt. 1, 1916, p. 48; Trans. Linn. Soc. London, vol. 11, ser. 2, 1916, p. 265; Bull. Soc. Sci. Hist. Nat. Corse, 1922, p. 131.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 158, pl. 41, figs. 9–12.

Polymorphina sulcata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 21.—FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 10, 1902, p. 52, fig. 52.

Variety having the wall marked by numerous longitudinal costae usually interrupted at the sutures and occasionally broken, especially in the basal area.

Length 0.30–0.40 mm.; breadth 0.25–0.35 mm.; thickness 0.25–0.35 mm.

Globulina sulcata, named by d'Orbigny in 1826, but figured much later by Fornasini, is undoubtedly the same as the present variety.

There are specimens in our collections from the following:

Recent.—Ireland, Steam Tug *Lord Bandon*, log. 33, Nymph Bank, south of Cork, 52 fathoms; log. 11, southwest of Ireland, 38–44 fathoms. England, off Plymouth. Italy, beach, Lido, Venice.

Pliocene.—England, Crag of Sutton. Italy, Castel Arquato.

Miocene.—Austria, Baden and Nussdorf.

Eocene.—France, Lutetien moyen, Grignon.

It may be noted that specimens from the Eocene of Grignon have very heavy costae as do also those of the Crag of Sutton.

GLOBULINA GIBBA d'Orbigny var. ORNATA (Karrer)

Plate 16, figure 9

Polymorphina ornata KARRER, Sitz. Akad. Wiss. Wien, vol. 58, abt. 1, 1868, p. 175, pl. 4, fig. 10.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 242, pl. 41, figs. 34*a*, *b*.

Variety ornamented with slightly raised warts or tubercles in more or less regular lines parallel to the long axis of the test.

Length 0.45–0.75 mm.; breadth 0.35–0.65 mm.; thickness 0.35–0.65 mm.

In the parallel arrangement of the broken costae, the present variety resembles var. *granulosa*, but it has a much coarser ornamentation. From *Globulina gibba* var. *myristiformis*, which has parallel broken costae, it is often very difficult to separate the present variety because of the intermediate forms. The variety is very abundant at Varpolata. The Eocene specimens are somewhat doubtfully of this variety, as is also that of Ahnatal.

We have specimens from the following localities:

Miocene.—Tortonian: Hungary, Varpolata; Kostej, Banat. Austria, Voslau brickyard, near Baden, near Vienna.

Oligocene.—Upper: Germany, Ahnatal, near Cassel (?).

Eocene.—Lutetien: France, Campbon (?).

GLOBULINA GIBBA d'Orbigny var. VERRUCOSA Cushman and Ozawa, new variety

Plate 17, figures 2 *a*, *b*

Polymorphina ornata HERON-ALLEN and EARLAND (not Karrer), Journ. Roy. Micr. Soc., 1909, p. 434, pl. 17, fig. 8.

Variety differing from the typical in ornamentation of the surface which consists of thick wart-like, raised areas, arranged generally in longitudinal lines.

Holotype: Length 0.35 mm.; breadth 0.33 mm.; thickness 0.33 mm.

Holotype.—(Cushman Coll. No. 11421.) From the Lutetien, Campbon, in France.

Polymorphina ornata described and figured by Heron-Allen and Earland from Selsey Bill, Sussex, England is identical with the present variety.

GLOBULINA GIBBA d'Orbigny var. FISSICOSTATA Cushman and Ozawa, new variety

Plate 17, figures 3 *a*, *b*

Variety differing from the typical in the ornamentation which consists of numerous fine, broken, longitudinal costae covering the entire surface.

Length 0.40–0.60 mm.; breadth 0.32–0.45 mm.; thickness 0.25–0.38 mm.

Holotype of variety.—(Cushman Coll. No. 11398.) From the upper Oligocene of Ahnatal, near Cassel, Germany, where the variety is very abundant. We have a single specimen from the Pliocene of Castel Arquato, Italy, that may belong to this variety.

GLOBULINA GIBBA d'Orbigny var. LONGITUDINALIS Cushman and Ozawa, new variety

Plate 18, figures 1 *a*, *b*

Variety differing from the typical form in its slightly compressed elongated test and its numerous, distinct, longitudinal costae. In its shape it is similar to *Globulina gibba* var. *globosa*, but it is ornamented by costae.

Holotype: Length 0.55 mm.; breadth 0.38 mm.; thickness 0.25 mm.

Holotype of variety.—(Cushman Coll. No. 11422.) From the Pliocene, Castel Arquato, Italy.

GLOBULINA GIBBA d'Orbigny var. TUBERCULATA d'Orbigny

Plate 17, figures 6, 7

Globulina tuberculata D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 230, pl. 13, figs. 21, 22.—TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 132, pl. 13 (21), figs. 33, 34.

Polymorphina (*Globulina*) *tuberculata* EGGER, Neues Jahrb. für Min., Jahrg. 1857, p. 292, pl. 14, figs. 7, 8.

Polymorphina tuberculata H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 242, pl. 41, fig. 35 *a–d*.—JONES, Foram. Crag, pt. 3, 1896, p. 273, pl. 5, fig. 29.—CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 603, pl. 20, fig. 5.

Globulina spinosa D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 230, pl. 13, figs. 23, 24.—TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 132, pl. 13 (21), fig. 35.

Polymorphina (*Globulina*) *spinosa* EGGER, Neues Jahrb. für Min., Jahrg. 1857, p. 292, pl. 14, figs. 9, 10.

Polymorphina spinosa H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 243, pl. 42, figs. 36 *a*, *b*.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, Sci., 1885, p. 347, pl. 12, fig. 27.—CUSHMAN, U. S. Geol. Surv. Prof. Paper 129–F, 1922, p. 133, pl. 31, fig. 5; Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 157, pl. 41, figs. 1, 13.

Globulina asperula GÜMBEL, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 10, 1870, p. 646, pl. 2, figs. 81 *a*, *b*.

Polymorphina frondiformis SEARLES WOOD var. *brevis* JONES, Crag Foram., Pal. Soc. Mon. 19, 1866–1897, p. 271, pl. 7, fig. 20.

Variety ornamented with strong spines of unequal size and irregularly spaced. Ozawa examined the original specimens of *Globulina tuberculata* and *G. spinosa*, which show no special difference excepting the size of the tubercles or spines, which are not equal even in an individual specimen. d'Orbigny figured forms of both extremes. We have a great many specimens of these two forms collected from the original locality which show every degree of ornamentation between d'Orbigny's two species.

Length with spines 0.70–0.90 mm.; breadth 0.60–0.80 mm.; thickness 0.50–0.70 mm.

Globulina asperula as described by Gümbel, having tubercles uniformly distributed, is undoubtedly the same as the present variety.

Polymorphina frondiformis var. *brevis*, recorded from the Crag by Jones, is described as having a subovate test with somewhat round chambers ornamented with irregular and subquadrate droplike beads and is evidently identical with the present variety *tuberculata*.

Ozawa examined d'Orbigny's specimens of *Globulina tuberculata* and *spinosa* in Paris and Vienna and is certain that they were obtained from Nussdorf and not Baden, as d'Orbigny records. The specimens show the same appearance as our Nussdorf specimens.

Distribution.—Specimens are in our collections from the following localities:

Pliocene.—Italy, Castel Arquato. England, Crag of Sutton.

Miocene.—Austria, Tortonian, *Amphistegina* marl of Grunes Kreuz, Nussdorf, Vienna; Ziegelgrube, Baden. Hungary, Kostej, Banat. France, Helvetian, Salles, Moulin du Minoy.

Oligocene.—Germany, upper Oligocene, Ahnatal, near Cassel. United States, lower Oligocene, Byram marl, Mississippi, Leaf River, ½ mile below bridge on Taylorsville-Silvarena road, near Old Blakney post office; Glendon limestone, Mississippi, from loose blocks of limestone below waterfall in Glass Bayou; Alabama, west bank of Conecuh River at McGowans Bridge, about 1 mile below mouth of Sepulga River; Mint Spring marl, Mississippi, below waterfall at Glass Bayou, Vicksburg; waterfall in Mint Spring Bayou, Vicksburg; Chickasawhay River, 1¼ miles northwest of mouth of Limestone Creek, 4 miles northwest of Waynesboro.

Eocene.—Germany, Hammer, Upper Bavaria.

GLOBULINA GIBBA d'Orbigny var. PUNCTATA d'Orbigny

Plate 17, figures 4, 5

Globulina punctata D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 229, pl. 13, figs. 17, 18.

Polymorphina hirsuta H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 243, pl. 42, fig. 37.—REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 486.—v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 34, figs. 1–3.—JONES and CHAPMAN, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 511, figs. 21 *a*, *b*, (in text).—JONES, Foram. Crag, pt. 3, 1896, p. 273, pl. 6, figs. 14 *a*, *b*.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1909, p. 435, pl. 17, fig. 7.—FRANKE, Abhandl. geol. pal. Instit. Univ. Greifswald, vol. 6, 1925, p. 79, pl. 6, fig. 22.

Globulina rugosa D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 229, pl. 13, figs. 19, 20.—TERQUEM, Essai Class. Anim. Dunkerque, 1876, p. 77, pl. 10, fig. 1.

Polymorphina rugosa CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 157, pl. 41, fig. 6.

Polymorphina globosa KARRER (not v. Münster), Sitz. Akad. Wiss. Wien, vol. 52, abt. 1, 1865, p. 497, pl., fig. 12.

Variety ornamented with small spines or punctations (not depressions, as described by d'Orbigny).

The original specimen in Paris is lost. Paratype specimens preserved in the geological department, Museum of Natural History in Vienna, are mostly *Orbulina universa* with a few *Globulina gibba* (some fistulose forms) and one specimen somewhat resembling the figure of *Globulina punctata* given by d'Orbigny. This is slightly elongated, just like a specimen in our collection from the Tortonian clay of Baden in the Vienna Basin. Brady, Parker, and Jones regarded *Globulina punctata* as representing a thin-walled condition in a shell of the common type of *Globulina gibba*, but the minute depressions on the surface noted by d'Orbigny are not depressions and do not represent the minute foramina in the chamber wall, but are surface ornamentations. Brady, Parker, and Jones separated the forms beset with fine spines as a distinct species, *Polymorphina hirsuta*, but such forms grade into typical variety *punctata*, and we think it is unnecessary to separate them.

Length 0.35–0.65 mm.; breadth 0.30–0.55 mm.; thickness 0.30–0.55 mm.

D'Orbigny's *Globulina rugosa*, described as having a globular test marked by longitudinally arranged depressions, was considered by several authors to be the same as *Polymorphina* (not *Globulina*) *rugosa*, having a peculiar test beset with spines, but there is no data whether d'Orbigny considered them as synonyms. The original specimens of these two species are lost, but paratype specimens of *Globulina rugosa* are in the Museum in Vienna and were examined by Ozawa. They are mostly *Globulina gibba* with one *Orbulina universa*, and there is nothing like the form figured by d'Orbigny.

If the specimen has the feature as illustrated by d'Orbigny and characterized by small depressions arranged longitudinally, then *Globulina rugosa* is considered to be nothing but *Globulina punctata*. In the middle Miocene (Tortonian) clay in the Vienna Basin Ozawa collected some *Globulina* ornamented with broken but strong costae, which resemble *Globulina myristiformis* Williamson. They appear to be *Globulina rugosa*, but there is no original specimen, and the paratype specimens are all quite different from the figure, therefore it is more advisable to place *Globulina rugosa* as a synonym of *Globulina gibba* var. *punctata* d'Orbigny.

Distribution.—We have specimens referable to this variety from the following:

Recent.—Mediterranean, Shoresand, Rimini; Island of Delos, 14 fathoms.

Pliocene.—England, Crag of Sutton. Italy, Castel Arquato.

Miocene.—Austria, Tortonian, Ziegelgrube, Vöslau, Vienna Basin; Baden, Vienna; Perchtoldsdorf, near Vienna; Bujtur, Siebenburgen.

Hungary, Lapugy. France, Helvetian, Moulin du Minoy, Salles; Burdigalien superior, Merignac (Gironde); Burdigalien moyen, Le Coquillat, Leognan; St. Paul de Dax, Dax.

Oligocene.—Germany, Ahnatal, near Cassel; Hildesheimerwald, Dickholzen; Doberg, near Bünde.

Eocene.—Lutetien, Parnes (Les Bôves); Lutetien, Grignon, Chaussy.

GLOBULINA GLACIALIS Cushman and Ozawa, new species

Plate 15, figures 6, 7

Test fusiform, slightly more acute at the base than at the apertural end; chambers more or less inflated, longer than wide, embracing, arranged in a clockwise, nearly triserial series, each succeeding chamber but little removed from the base, often with an extra chamber added higher up on the test; sutures very slightly depressed, distinct; wall smooth, thin, almost transparent; aperture radiate.

Length 0.30–0.45 mm.; breadth 0.14–0.22 mm.; thickness 0.12–0.18 mm.

Holotype.—(Cushman Coll. No. 11456.) From Pleistocene clays of the Glen, Montreal, Canada.

In general aspect it resembles *Globulina minuta* of the European Tertiary, but its arrangement of chambers is in a clockwise spiral (almost triserial) series instead of contraclockwise, as in *G. minuta*. There are some specimens with one extra chamber which is invariably inflated and added higher up on the test, while in *G. minuta* an extra chamber shows no great difference in position from the others.

Distribution.—This species is a cold-water one found in the glacial clays of Canada and New England and living in very cold waters.

Recent.—Canada, Murray Bay, Province of Quebec.

Pleistocene.—Canada, glacial clays, the Glen, and McGill College Grounds, Montreal. United States, Leda clay, Portland, Me.

GLOBULINA LANDESI (G. D. Hanna and M. A. Hanna)

Plate 15, figures 9 *a*, *b*

Polymorphina landesi G. D. Hanna and M. A. Hanna, Publ. Geol. Univ. Washington, 1924, vol. 1, no. 4, p. 60, pl. 13, figs. 16, 17.

Test compressed, almost circular in outline except for the produced apertural end; chambers elongated, much embracing, arranged in a more or less triserial series, each succeeding chamber not removed from the base; sutures not depressed but distinct; wall smooth, rather thick; aperture produced, radiate.

Figured specimens: Length, 0.45 mm.; breadth, 0.35 mm.; thickness, 0.25 mm.

The present species is one of the few Globulinas described from the Pacific region and was described from the Eocene of North America.

It is the only species of *Globulina* found in Japanese Recent and Tertiary material. It is characterized by an almost circular test, and

the chambers are much embracing. European *Globulina inaequalis* has a compressed and rounded test, but not as regularly circular as the Japanese species. A young stage of *Sigmomorphina semitecta* resembles the present species, but it is more compressed and invariably elongated.

Distribution.—G. D. Hanna and M. A. Hanna described the present species from the Eocene in Lewis County, Wash. Japanese specimens are from shore sand, Kobama (Sea of Japan), Province of Echizen. We have a few specimens which are very similar to the present species from various European Tertiary deposits: Pliocene of Castel Arquato, Italy; Miocene, Burdigalien inferieur, Moulin de l'Eglise, Saucats, France; and Eocene, Lutetien, Parnes (Les Bôves), France. A specimen from the Tortugas, off Florida in 11 fathoms, is also very similar.

GLOBULINA DENTIMARGINATA (Chapman)

Plate 15, figures 10 *a*, *b*

Polymorphina concava WILLIAMSON var. *dentimarginata* CHAPMAN, Quart. Journ. Geol. Soc., vol. 50, 1894, p. 717, pl. 34, fig. 14 *a*, *b*.—JONES and CHAPMAN, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 514, figs. 35 *a*, *b* (in text).

"Test adherent, flat on the attached and convex on the opposite face, subovate in outline, and sharply pointed at both ends on the upper and lower surfaces, in the central area of the test, is exhibited a regular Polymorphine series, consisting of five chambers on the upper surface, and surrounding this is a secondary or later growth of shell material, depauperate and thin, which appears to turn back upon the under surface, forming the adherent portion. The thin outer flangelike portion of the test shows the septation of five flattened segments. The delicate margin of the test is broken up into a fine pectinate edge, and by careful observation the surface is seen to be studded sparsely with minute prickles. Length, one thirty-eighth inch (0.65 mm.); width, one eighty-fifth inch (0.30 mm.)."

We have no specimen representing the present species. Considered from the original figures and descriptions, *Globulina dentimarginata* is quite different from *Sigmomorpha concava* in its arrangement of chambers and can be safely separated as a good species. The arrangement of chambers of the present species appears to be abnormal from that of a regular *Globulina*, considering this from the arrangement of chambers, and it seems to be a specialized globular species of *Quadrulina*, but we can not say anything definite without examining the original specimen. Therefore the present species is provisionally included in *Globulina*. The above description is copied in full from the original.

Chapman's specimens were from the Cretaceous, Bargate beds of Surrey, England.

GLOBULINA PRISCA Reuss

Plate 12, figures 6 *a–c*

Globulina prisca REUSS, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 79, pl. 9, fig. 8.

Polymorphina acuta OLSZEWSKI, Sprawozd. Kom. Fizyj. Ak. Umiej. Krakowie, vol. 9, 1875, p. 120, pl. 1, fig. 13.

Polymorphina fusiformis CHAPMAN (not Roemer), Journ. Roy. Micr. Soc., 1896, p. 11, pl. 2, fig. 9 (not fig. 10).

Test elongate, fusiform, more or less compressed, acuminate toward both ends; chambers elongate, tapering to the base, arranged in an almost triserial series; sutures but little depressed; wall smooth; aperture radiate.

Length, 0.50–0.80 mm.; breadth, 0.25–0.35 mm.; thickness, 0.18–0.27 mm.

This is one of the more common species among the Cretaceous Polymorphinidae. It resembles compressed *Globulina minuta* in the Tertiary, with which it may be confused, but *Globulina prisca* is always compressed and usually very slender, its later chambers generally coming down almost to the base, while in *Globulina minuta* the test is as a rule typically fusiform with a circular section and the later chambers removed farther from the base.

As Olszewski's *Polymorphina acuta* is not well drawn, we can not be positive without seeing the types, but it seems to be very close to *Globulina prisca*.

Distribution.—This species is fairly common in the Cretaceous of Europe and America. We have specimens as follows:

Cretaceous.—England, Cambridge greensand, Saxon Cement Works, Cambridge; chalk marl, Saxon Cement Works, Cambridge and Folkestone; lower Gault, Barnwell pit, Cambridge, and bed VI, Gault of Folkestone. Germany, upper Senonian. Dasbeck b. Hanover, Westphalia. Mexico, numerous specimens from Upper Cretaceous, Velasco shale, Hacienda El Limon, west of Panuco.

GLOBULINA INAEQUALIS Reuss

Plate 18, figures 2–4

Globulina inaequalis REUSS, Denkschr. K. Akad. Wiss. Wien, vol. 1, 1850, p. 377, pl. 48, fig. 9.

Globulina discreta REUSS, Denkschr. K. Akad. Wiss. Wien, vol. 1, 1850, p. 378, pl. 48, fig. 10.

Globulina amplectens REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 81, pl. 6, fig. 44.

Globulina inflata REUSS, Zeitschr. deutsch Geol. Ges., vol. 3, 1851, p. 81, pl. 6, fig. 45.

Globulina amygdaloides REUSS, Zeitschr. deutsch. Geol. Ges., vol. 3, 1851, p. 82, pl. 6, fig. 47.

Polymorphina amygdaloides REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 486.— v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 27, figs. 7–9, 10–12.

Guttulina diluta BORNEMANN, Zeitschr. deutsch. geol. Ges., vol. 12, 1860, p. 160, pl. 6, fig. 11 *a*, *b*, *c*.

Polymorphina pauperata TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 38, pl. 3 (8), figs. 11 *a*–19.

Globulina translucida D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 25.—TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 131, pl. 13 (21), fig. 31 *a*, *b*.

Polymorphina translucida FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 10, 1902, p. 52, fig. 51.

Test ovate, more or less compressed, broadly rounded at the base, tapering toward the apex; chambers few, inflated, much overlapping, arranged in a nearly triserial series; sutures very slightly if at all depressed, distinct; wall smooth, translucent; aperture radiate.

Length, 0.50–0.85 mm.; breadth, 0.45–0.85 mm.; thickness, 0.25–0.50 mm.

As in the case of *Globulina gibba*, many different specific names are given to divergent forms of the globular, but compressed variety of *Globulina*, among which *Globulina inaequalis* Reuss has the priority. *Globulina discreta* Reuss reported in 1850 from the same locality as the present variety seems to us an abnormal form of the typical.

Reuss's several names given to the middle Oligocene compressed Globulinas are considered by the authors, after the examination of a great number of topotype specimens to be nothing but individual variations of one species, and they are placed with the Miocene *Globulina inaequalis*. Bornemann's *Guttulina diluta* has a rounded test and is not at all compressed. It might appear to be more reasonable to put it in *Globulina gibba* than in *inaequalis*, but we consider it an abnormal form of the present species, having the later chambers not fully developed.

Globulina translucida, named by d'Orbigny and illustrated much later by Terquem as well as by Fornasini, in its every respect is identical with the present species. *Guttulina nitida* d'Orbigny, figured by Fornasini, is doubtlessly related to the present one, as it has rather elongate chambers.

Distribution.—Our material includes the following localities:

Recent.—Mediterranean, shore sand, Rimini. Pacific, Australia, Torquay, on Bass Strait, Victoria. New Zealand, off Poor Knights Islands, 60 fathoms; off the Big King, 98 fathoms.

Pliocene.—United States, Santa Barbara, Calif. England, Crag, Sutton.

Miocene.—France, Helvetian, Moulin du Minoy, Salles; Aquitanian superieur, La Brêde, Larriey; St. Avit, near Mont de Marson; Burdigalien superieur, Pont Gourguet, Saucats; Burdigalien moyen, Le Coquillat, Leognan; St. Paul de Dax, Dax; Burdigalien inferieur, Moulin de l'Eglise, Saucats. Germany, Dingden, near Bochaft, Westphalia. Austria, Tortonian, *Amphistegina* marl, Grunes Kreuz,

Nussdorf, Vienna; Voslau, Vienna. Hungary, Tortonian, Varpolata; Kostej, Banat; Lapugy. United States, Yellow River, Fla., three-fourths mile east of Red Bay, Walton County, Fla.

Oligocene.—Germany, Ahnatal, near Cassel; Doberg near Bünde; Wiesloch, near Heidelberg; Lobsann; Flonheim, Mainz Basin; Hermsdorf, near Berlin; Cothen; Düsseldorf, Ratigen; Oeding. France, Stampien, Jeurs (Seine et Oise). United States, Byram marl, Byram, Miss.; southwest bank of Chickasawhay River, 500 feet west of bridge, 2½ miles south of Waynesboro, Miss.

Eocene.—France, Lutetien, Parens (Les Bôves); Lutetien, Grignon, Chaussy; Damery. England, Bracklesham bed XVII, White Cliff Bay, Isle of Wight; from Bracklesham material washed up on beach at Selsey; Thanetian, bed B, Pegwell Bay. Belgium, lower Eocene, Wansin. Germany, Hanover, upper Bavaria. Hungary, Neustift, Ofen. United States, Jacksonian, three-fourths mile below Robinson's Ferry, Sabine River, Sabine County, Tex., Cooper marl, pit on United States Highway No. 17, 1 mile south of Moncks Corner, Berkeley County, S. C.; Claibornian, Vincentown, N. J.; Midwayan, Tex.

GLOBULINA INAEQUALIS Reuss var. **CARIBAEA** d'Orbigny

Plate 18, figures 5, 6

Globulina caribaea D'ORBIGNY, in de la Sagra., Hist. Fis. Pol. Nat. Cuba, vol. 6, 1840, p. 130, pl. 2, figs. 7, 8.

Polymorphina leprosa REUSS, Sitz. Akad, Wiss. Wien, vol. 55, pt. 1, 1867, p. 89, pl. 4, fig. 3.

Polymorphina horrida KARRER, Abhandl. k. k. geol. Reichsanst, vol. 9, 1877, p. 385, pl. 16*b*, fig. 46.

Polymorphina asperella KARRER, Abhandl. k. k. geol. Reichsanst, vol. 9, 1877, p. 385, pl. 16*b*, fig. 47.

Globulina hispida TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 131, pl. 13 (21), fig. 32.

Polymorphina spinosa SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 51, no. 9, 1907, p. 15, pl. 3, figs. 10, 11.

Polymorphina lactea CUSHMAN, Carnegie Instit. Washington, Publ. No. 311, 1922, p. 34, pl. 4, figs. 10, 11.

Variety differing from the typical, the wall ornamented, wholly or partly, with fine short spines.

Length 0.45–0.50 mm.; breadth 0.38–0.40 mm.; thickness 0.22–0.25 mm.

D'Orbigny's original specimen is lost. We have studied the material dredged from off Cuba and adjacent areas, and obtained several specimens close to *Globulina caribaea*, but in which the spiny ornamentation covers the entire surface and the sutures are not as much depressed as shown in the figure of *Globulina caribaea* as well as described by d'Orbigny. But the surface ornamentation of any species of the Polymorphinidae is subject to variation; therefore we have placed our specimens under d'Orbigny's species.

Polymorphina rugosa, described in the same paper by d'Orbigny, has an abnormally enlarged but compressed last chamber. Although treated by d'Orbigny as a distinct species from *Globulina caribaea*, we consider it better to include it in that species.

There are many other names given to ornamented, compressed forms of *Globulina* by various authors, of which *Polymorphina leprosa* Reuss, recorded from the Miocene (Salzthone) in Galicia, is a form with more or less depressed sutures and the surface marked with roughly scattered spines.

Polymorphina asperella Karrer and *Globulina hispida* Terquem are characterized by fine spines uniformly distributed, while in *Polymorphina horrida* Karrer, having one extra chamber, the spines are much stouter, giving the rough appearance to the surface.

Globulina caribaea is often found attached to shells by its flattened surface.

Distribution.—Often found in various Tertiary deposits, as well as in Recent shallow-water dredgings. Our specimens were obtained from the following localities:

Recent.—Atlantic, numerous stations off the Dry Tortugas, Fla., 10–18 fathoms; beach sand, Newport, R. I.; *Albatross* D2112, 15.5 fathoms, and D2262, 250 fathoms, east coast of United States.

Miocene.—France, Burdigalien moyen, Le Coquillat, Leognan; Burdigalien inferieur, Moulin de l'Eglise, Saucats.

Oligocene.—Germany, Ahnatal, near Cassel.

Eocene.—France, Lutetien, Parnes (Les Bôves); Lutetien, Grignon; Courtagnon; Damery.

GLOBULINA INAEQUALIS Reuss var. DOLLFUSSI Cushman and Ozawa, new variety

Plate 18, figure 7

Variety differing from the typical form in its attached state.

Holotype: Length, 0.55 mm.; breadth, 0.47 mm.; thickness, 0.27 mm.

Holotype of variety.—(Cushman Coll. No. 11547.) From the Miocene, lower Burdigalien, Le Coquillat, Leognan, near Bordeaux, France.

This variety is named for Professor Dollfuss of Paris.

GLOBULINA INAEQUALIS Reuss var. SPINATA Cushman and Ozawa, new variety

Plate 17, figures 1 *a*, *b*

Variety differing from the typical in its attached state and spiny surface.

Holotype: Length, 0.30 mm.; breadth, 0.25 mm.; thickness, 0.16 mm.

Holotype of variety.—(Cushman Coll. No. 11546.) Found in the upper Oligocene at Cassel, Ahnatal, Germany.

GLOBULINA LACRIMA Reuss

Plate 19, figures 1, 2

Polymorphina (*Globulina*) *lacrima* Reuss, Die Verstein. böhm. Kreide., 1845, p. 40, pl. 12, fig. 6; pl. 13, fig. 83.—Egger, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 125, pl. 17, figs. 39, 40.

Globulina lacrima Reuss, Haidinger's Nat. Abhandl., vol 4, 1851, p. 27, pl. 4, fig. 9.

Globulina lacrynia Alth, Haidinger's Nat. Abhandl., vol. 3, 1850, p. 263, pl. 13, fig. 16.

Polymorphina gibba Chapman (not d'Orbigny), Journ. Roy. Micr. Soc., 1896, p. 9, pl. 2, fig. 5.—Egger, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 128, pl. 17, figs. 19, 20.—Franke, Abhandl. geol. pal. Instit. Univ. Greifswald, vol. 6, 1925, p. 76, pl. 6, fig. 15 *a*, *b*.—Cushman, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 604, pl. 20, figs. 8, 15.—Franke, Danmarks Geol. Unders. II, Raekke, No. 46, 1927, p. 32, pl. 3, fig. 9.

Polymorphina longicollis Karrer, Jahrb. k. k. geol. Reichsanstalt, vol. 20, 1870, p. 181, pl. 2, fig. 11.

Polymorphina gutta Chapman (not d'Orbigny), Journ. Roy. Micr. Soc., 1896, p. 10, pl. 2, fig. 7.—Franke (not d'Orbigny), Danmarks Geol. Unders. II, Raekke, No. 46, 1927, p. 33, pl. 3, fig. 11.

Polymorphina lactea Egger (not Walker and Jacob), Ber. nat. Ver. Passau, 1907, p. 40, pl. 4, fig. 24.

Test subglobular, the base broadly rounded, apertural end produced and regularly acuminate, the sides straight and not concave, typically rounded in end view; chambers few, extending back almost to the base; sutures not depressed; wall smooth; aperture radiate, slightly produced.

Length, 0.55–0.75 mm.; breadth, 0.40–0.55 mm.; thickness, 0.40–0.55 mm.

We do not deny that the Cretaceous *Globulina lacrima* is very close to and almost identical with Tertiary and Recent *Globulina gibba*. If, however, we should examine *Globulina lacrima*, or Cretaceous *Globulina gibba* identified by other authors, we would be surprised to find all specimens constant in their characters. The apertural end is definitely produced. The Cretaceous specimens of both Europe and America that we have examined are constant in this character. Among Tertiary and Recent *Globulina gibba* there are some which have a produced aperture as in *Globulina gibba* var. *pyrula* Egger, but in this case the side is always concave instead of straight as in *G. lacrima*. *Polymorphina longicollis* Karrer is described as having a compressed test, and may be distinct from the present species. *Polymorphina ovulata* Dunikowski, judging from the figure, appears to be a young stage of *Marginulina;* but if it be *Globulina*, it would be related to *Globulina lacrima*.

Distribution.—The geological range seems to be limited. We have specimens from the Cretaceous, both of America and Europe. The localities are: England, chalk marl, Folkestone; Saxon Cement

Works, Cambridge. France, chalk, Bougival. Germany, Galling, near Siegsdorf, Upper Bavaria; Dasbeck, Stemmerberg, and Rinkerode, Westphalia; Merkinghaven, near Henrichburg, Westphalia. Trinidad, Lizard Spring. Mexico, Velasco shale, Hacienda El Limon, Vera Cruz. United States, Navarro formation, clay pit, 3 miles south of Corsicana, Tex.

GLOBULINA LACRIMA Reuss var. SUBSPHAERICA (Berthelin)

Plate 19, figures 5–7

Polymorphina subsphaerica BERTHELIN, Mém. Soc. Géol. France, sér. 3, vol. 1, 1880, p. 58, pl. 4, fig. 18 *a*, *b*.

Polymorphina gibba JONES and CHAPMAN (not d'Orbigny), Journ. Linn. Soc. Zool., vol. 25, 1896, p. 509, fig. 5 (in text).

Variety differing from the typical in the slightly compressed test, which is more rounded at the base than at the apertural end.

Length 0.33–0.45 mm.; breadth 0.30–0.40 mm.; thickness 0.20–0.30 mm.

This variety of the Cretaceous is a slightly compressed *Globulina lacrima* with a rounded base. Somewhat similar forms can be found among the Tertiary and Recent *Globulina gibba*, but like the typical form of *Globulina lacrima*, the variety keeps its definite character, so far as we have examined specimens from the Cretaceous, both of Europe and America.

Distribution.—We have specimens representing the following Cretaceous localities: England, lower Gault, Barnwell pit, Cambridge; brickyard, Cambridge. Germany, Stemmerberg, Westphalia; Galling, near Siegsdorf, Upper Bavaria; Turonian, Hinter-Fessen, near Pirna. United States, Navarro formation, clay pit, 3 miles south of Corsicana, Tex.; core at Mexia, 248–455′. Ripley formation, 3½ miles northeast of Ripley Bluff, on Owl Creek, Miss. Mexico, Velasco shale, Hacienda El Limon, Vera Cruz.

GLOBULINA LACRIMA Reuss var. ERICIA Cushman and Ozawa, new variety

Plate 19, figure 4

Polymorphina gutta JONES and CHAPMAN, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 513, fig. 29 (in text).—CHAPMAN, Journ. Roy. Micr. Soc., 1896, p. 10, pl. 2, fig. 8.

Variety differing from the typical in the ornamentation of the test, consisting of scattered, stout, blunt spines, often unequally distributed.

Holotype: Length, including spines, 0.65 mm.; breadth 0.40 mm.

Holotype of variety.—(Cushman Coll. No. 11574.) From the chalk marl of Saxon Cement Works, Cambridge England. Paratype in collection of Geological Institute, Imperial University of Tokyo, Japan.

The variety can be compared with *Globulina gibba* d'Orbigny var. *tuberculata* d'Orbigny in its stout spiny ornamentation, but the form of the test and the tapering apertural end will distinguish the two.

GLOBULINA LACRIMA Reuss var. HORRIDA Reuss

Plate 19, figure 3

Globulina horrida Reuss, Verstein. Böhm. Kreide, pt. 2, 1845–46 (1846), p. 110, pl. 43, fig. 14; Haidinger's Nat. Abhandl., vol. 4, 1851, p. 27, pl. 4, fig. 8.—Jones and Chapman, Journ. Linn. Soc. Zool., vol. 25, 1896, p. 510, fig. 10 (in text); p. 511, fig. 16 (in text).

Polymorphina horrida Egger, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 130, pl. 17, fig. 16.

Aulostomella pediculus Alth, Haidinger's Nat. Abhandl., vol. 3, 1850, p. 264, pl. 13, fig. 17.

Polymorphina orbignii Weller (not Zborzewski), Geol. Surv. New Jersey, Paleontology, vol. 4, 1907, p. 252, pl. 3, fig. 26.

Variety differing from the typical in having the surface finely spinose and usually the apertural end fistulose.

Length 0.40–0.75 mm.; breadth 0.22–0.30 mm.; thickness 0.20–0.30 mm.

This variety occurs with the typical form in the Cretaceous of Europe and America and is to be distinguished from the typical form mainly by the two characters, the ornamentation of the surface and the peculiar arrangement of the fistulose outgrowths which are somewhat regularly stellate.

Distribution.—We have specimens from the following Cretaceous localities: Germany, Galling, near Siegsdorf, Upper Bavaria. England, Cambridge greensand, Saxon Cement Works, Cambridge. United States, Navarro formation, clay pit 3 miles south of Corsicana, Tex.

GLOBULINA AMPULLA (Jones)

Plate 19, figures 9 *a–c*

Polymorphina ampulla Jones, Quart. Journ. Geol. Soc., vol. 8, 1852, p. 267, pl. 16, fig. 14.

Polymorphina gibba d'Orbigny var. *ampulla* Burrows and Holland, Proc. Geol. Assoc., vol. 15, 1897, p. 45, pl. 2, fig. 14.

Guttulina nitida d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 17.—Fornasini, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 9, 1901, p. 70, fig. 22.

Polymorphina lactea Chapman (not Walker and Jacob), Journ. Roy. Micr. Soc., 1896, p. 9, pl. 2, fig. 3.

Polymorphina lactea Plummer (not Walker and Jacob), Bull. 2644, Univ. Texas, 1927, p. 121, pl. 6, figs. 7 *a–c*.

Test oval, pointed at both ends, unequally convex; chambers few, each slightly farther from the base as added; sutures very slightly

depressed, distinct; wall smooth, thin, almost transparent, initial end sometimes with spines; aperture very finely radiate, produced.

Length 0.40–0.75 mm.; breadth 0.30–0.60 mm.; thickness 0.25–0.50 mm.

Globulina ampulla has been neglected by later authors probably because of its resemblance to *Globulina gibba*. It is different from the latter in its pointed end, often with a spine and slightly depressed sutures which are stronger at the base.

Distribution.—Jones described this form from the lower Eocene, Thanetian beds of Pegwell Bay, England. We have specimens from the Eocene of France from the Lutetien of Parnes (Les Bôves) and Vaudancourt. A specimen from the Burdigalien inferieur of Moulin de l'Eglise, Saucats, France, is also referred here with some question.

GLOBULINA EXSERTA (Berthelin)

Plate 20, figures 2 *a–c*

Polymorphina exserta BERTHELIN, Mém. Soc. Géol. France, sér. 3, vol. 1, 1880, p. 57, pl. 4, figs. 22 *a*–23 *b*.

Polymorphina bucculenta BERTHELIN, Mém. Soc. Géol. France, sér. 3, vol. 1, 1880, p. 58, pl. 4, figs. 16 *a*–17 *b*.

Test more or less compressed, oval to ovate, initial end often produced; chambers inflated, earlier ones small, later ones much larger, not much embracing, arranged in a nearly triserial series; sutures but little depressed, distinct; wall smooth; aperture radiate.

Length 0.55–0.60 mm.; breadth 0.30–0.35 mm.; thickness 0.23–0.27 mm.

Berthelin described two species of *Polymorphina: P. exserta*, and *P. bucculenta* which appear to be closely related to each other. They have the early chambers relatively small, the last two large, and show no great difference in important characters. *P. bucculenta* is rather unsymmetrical compared with the other, because the last chamber does not extend down to the base. *P. exserta* has a produced initial chamber. Such differences are not important as shown by Berthelin's figures of two individuals of *P. bucculenta* which he considered to be individual variation.

We have many specimens of the present species from both European and North American Cretaceous, and we are convinced that the species is variable in the range shown by Berthelin's figures of the above cited species.

Distribution.—*P. exserta* is apparently limited to the Cretaceous and is very common in the Lower Cretaceous. The localities of our specimens are: Cretaceous, England, chalk marl, Saxon Cement Works, Cambridge; Cambridge greensand, same locality. United States, Goodland formation, near Fort Worth, Tex.

GLOBULINA FLEXA Cushman and Ozawa, new species

Plate 20, figures 1 *a–c*

Test longer than broad, greatest width above the middle, sides not equally convex, base broad but tending to become pointed at the middle, round in transverse section; chambers few, extending well toward the base; sutures distinct, doubly curved in a sigmoid manner, the upper part convex, the basal portion concave; wall smooth, translucent; aperture radiate, somewhat extended.

Length 0.60–0.70 mm.; breadth 0.32–0.37 mm.; thickness 0.25–0.30 mm.

Holotype.—(Cushman Coll. No. 11,587.) From upper Oligocene, Doberg, near Bünde, Germany.

The elongate test and the doubly curved sutures in a sigmoid manner are very characteristic of the species, and there is little danger of confusing *Globulina flexa* with any other species or varieties of *Globulina*. The nearest species is *Globulina ampulla*, having a broadly rounded base pointed at the middle as in the present species, but *Globulina flexa* has a longer test with sigmoid, curved sutures.

Soldani's *Polymorphium pyriformium*, compared by d'Orbigny with his *Pyrulina gutta*, has an elongate test, and its sutures are curved in a sigmoidal manner and is probably identical with the present species.

Distribution.—We have specimens of this striking and beautiful foraminifer from the upper Oligocene of Ahnatal, near Cassel, Germany. A very similar form occurs in Recent material from Dogs Bay, Ireland.

GLOBULINA GRANULOSA Egger

Plate 20, figures 5, 7

Polymorphina (*Globulina*) *granulosa* Egger, Neues Jahrb. für Min., Jahrg. 1857, p. 290, pl. 14, figs. 1, 2.

Polymorphina granulosa H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 238, pl. 41, figs. 26 *a*, *b*.

Globulina grateloupi d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 23.

Polymorphina (*Globulina*) *grateloupi* Fornasini, Riv. Ital. Pal., vol. 8, 1902, p. 2, pl. 1, fig. 6.

Globulina elongata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 24.

Polymorphina (*Globulina*) *elongata* Fornasini, Riv. Ital. Pal., vol. 8, 1902, p. 2, pl. 1, fig. 7.

Test oval, rounded at the initial end, more or less acute toward the aperture, nearly circular in end view; chambers few, arranged in an almost triserial series, the last-formed one generally much removed from the base; sutures not depressed, often indistinct; wall fairly thick, ornamented by numerous fine longitudinal costae not greatly raised, independent of the sutures and close together; aperture broad, radiate, slightly produced.

Length, 0.50–0.65 mm.; breadth, 0.30–0.42 mm.; thickness, 0.30–0.40 mm.

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Polymorphina granulosa Egger seems to be closer to *Globulina striata* in general features, especially in its shape, but the paratype specimen of the latter examined by us is an ornamented *Globulina gibba*, and the test is not elongated as in *Polymorphina granulosa*.

D'Orbigny's *Globulina grateloupi* and *Globulina elongata*, both from Dax and figured by Fornasini, coincide in their general features with the present species; the differences are the more acuminate apertural end and slightly compressed test. We have examined a large number of specimens from Dax and Bordeaux which are referable to *Globulina grateloupi* or *G. elongata*, and found that most specimens are closer to Egger's *Globulina granulosa*.

Globulina granulosa is distinguished from other related Globulinas by its elongate test.

Distribution.—The species is rather common in European younger Tertiary deposits. Our specimens represent the following localities:

Miocene.—France, Burdigalien superieur, Pont Pourguet, Saucats; Burdigalien moyen, Le Coquillat, Leognan; St. Paul de Dax, Dax; Burdigalien inferieur, Moulin de d'Eglise, Saucats. Germany, Ortenberg.

GLOBULINA GRANULOSA Egger var. POLITA (Terquem)

Plate 21, figures 1 *a–c*

Polymorphina polita TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 139, pl. 14 (22), figs. 23–25.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 224, pl. 44, fig. 11.

Guttulina laevigata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 19.—FORNASINI, Mem. R. Accad. Sci. Istit. Bologna, ser. 6, vol. 5, 1908, p. 43, pl. 1, figs. 10, 10 *a*, 10 *b*.

Polymorphina pupa D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 9.—FORNASINI, Riv. Ital. Pal., vol. 8, 1902, p. 2, pl. 7, fig. 3.

Variety differing from the typical in its surface, which is smooth.

Among the figures of *Polymorphina polita* Terquem from the Eocene of Vaudancourt, at least figure 25 can be included in the present variety. His figure 24 shows a specimen having the last chamber much farther removed from the base and the Figure 23 having the chamber still more removed. We place them under this variety with some doubts. *Polymorphina obscura* d'Orbigny, figured by Terquem, resembles figure 23 of *Polymorphina polita*, the difference being only in the compressed test. D'Orbigny's *Guttulina laevigata*, figured by Fornasini, is probably a shorter form of the present variety.

Length, 0.40–0.80 mm.; breadth, 0.23–0.55 mm.; thickness, 0.20–0.50 mm.

Distribution.—We have specimens from the following localities:

Pliocene.—England, Crag of Sutton (?). Italy, Castel Arquato.

Miocene.—France, Aquitanian superieur, St. Avit, near Mont de Marsan; Burdigalien moyen, Le Coquillat, Leognan; Burdigalien

inferieur, Moulin de l'Eglise, Saucats. Austria, Tortonian, Streibersdorf; Voslau, near Baden, Vienna Basin.

Oligocene.—Upper, Germany, Ahnatal, near Cassel. Lower, Lattdorf (?).

Eocene.—Italy, Bartonian, Val di Lonte (?).

GLOBULINA MINUTA (Roemer)

Plate 20, figures 3, 4

Polymorphina minuta ROEMER, Neues Jahrb. f. Min., etc., 1838, p. 386, pl. 3, fig. 35.—REUSS. Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 486.—v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 27, figs. 13–15; pl. 25, figs. 51–56.—BORNEMANN, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 344, pl. 17, fig. 3.

Polymorphina (*Guttulina*) aff. *minima* ANDREAE, Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, pt. 3, 1884, p. 118, pl. 9, fig. 16.

Polymorphina similis REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 249, pl. 7, fig. 79.

Polymorphina sororia REUSS, Sitz. Akad. Wiss. Wien, vol. 48, pt. 1, 1863, p. 57, pl. 7, figs. 72 (?), 73, 74; Bull. Acad. Roy. Sci. Belg., ser. 2, vol. 15, 1863, p. 151, pl. 2, fig. 25 (not 26–29).

Polymorphina gracilis REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 486.—v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 31, figs. 34–37, 42, 45–49; pl. 32, figs. 5–16, 27, 28.

Polymorphina acuta REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 486.—v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 27, figs. 19–21; pl. 29, figs. 15, 16, 43–46.

Polymorphina lactea BURROWS, SHERBORN, and BAILEY (not Walker and Jacob), Journ. Roy. Micr. Soc., 1890, p. 561, pl. 11, figs. 9, 10.—EGGER, Abhandl. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 308, pl. 9, figs. 8, 14, 15.—MILLS, Trans. Hull. Sci. & Field Nat. Club, vol. 1, 1900, p. 149, pl. 11, fig. 33.

Polymorphina lactea elongate variety, WELLER, Geol. Surv. New Jersey, Paleontology, vol. 4, 1907, p. 251, pl. 3, figs. 24–25.

Test fusiform, pointed at both ends, circular to elliptical in section; chambers few, elongate, each some distance from the base; sutures distinct, not depressed; wall smooth; aperture radiate, pointed.

Length 0.50–0.70 mm.; breadth 0.20–0.35 mm.; thickness 0.20–0.35 mm.

This is an elongate, fusiform *Globulina*, having the chambers arranged as in *Globulina gibba*. *Globulina similis*, described as having seven chambers, may represent the microspheric form of the present species. It has a slightly compressed test and is placed as intermediate between Bornemann's *Globulina minima* and Roemer's *Globulina minuta*. The latter two forms may be considered to represent both extremes in the degree of the compression of the test. Among *Polymorphina gracilis* Reuss, which name is given to Schlicht's figures, there are some which can be included in *Globulina minuta*. They are the figures 5–8 and 27, 28 in Plate 32.

Very distinct characters are lacking to make this a well-defined species. Early stages of other Polymorphinidae are often very similar to this and may be confused with it.

Distribution.—Our specimens, some of them referred very questionably to this species, are from the following localities:

Recent.—Tripoli.

Pliocene.—Fiji.

Miocene.—Hungary, Lapugy.

Oligocene.—Germany, Düsseldorf; Söllingen; Oeding.

Eocene.—France, Lutetien, Grignon; Chaussy. Italy, Bartonian, Val di Lonte. Belgium, Wansin. United States, Jacksonian, east bank of Sepulga River, 6½ miles north of Brooklyn, Conecuh County, Ala. Trinidad, Cipero section.

GLOBULINA GRAVIS (Karrer)

Plate 21, figures 2 *a–c*

Polymorphina gravis KARRER, Jahrb. k. k. geol. Reichsanstalt, vol. 20, 1870, p. 181, pl. 2, fig. 12.

Test ovate, rounded at the base, acute at the apertural end; chambers inflated, oval, arranged in a nearly triserial series; sutures slightly depressed, distinct; wall smooth; aperture radiate.

Figured specimen length 1.10 mm.; breadth 0.60 mm.; thickness 0.50 mm.

Globulina gravis, in its general features, resembles *Globulina rotundata*, but it has more elongated chambers, and the test is very acute toward the apertural end. It is evidently related to *Globulina lacrima*, while *Globulina rotundata* is derived from *Globulina gibba*.

Distribution.—*Globulina gravis* is limited to the Cretaceous. We have specimens from Maastricht, Holland, and from the Cambridge greensand, Saxon Cement Works, Cambridge, England.

GLOBULINA AMPLA (Karrer)

Plate 21, figure 5

Polymorphina ampla KARRER, Jahrb. k. k. geol. Reichsanstalt, vol. 20, 1870, p. 181, pl. 2, fig. 13.

Test oval, somewhat rounded at both ends; chambers few, slightly longer than wide, embracing, arranged in a nearly triserial series, each succeeding chamber more or less removed from the base; sutures not depressed, distinct; wall smooth; aperture radiate.

Figured specimen, length 0.60 mm.; breadth 0.50 mm.; thickness 0.40 mm.

The present species is described as having a coarse test which would probably be affected by fossilization. Our specimen obtained from the uppermost Cretaceous at Maastricht is very similar to Karrer's species in general features, but the wall is smooth. It may represent

a Cretaceous form corresponding to Tertiary *Globulina rotundata*, which has almost the same features.

GLOBULINA CONSOBRINA (Fornasini)

Plate 21, figures 6 *a–c*

Polymorphina sororia Reuss var. *consobrina* Fornasini, Mem. Istit. Bologna Accad. Sci., ser. 5, vol. 18, 1900–1902, p. 69, fig. 21 (in text).

Test typically fusiform, pointed at both extremities; chambers rounded, arranged in an almost triserial series; sutures depressed but little, distinct; wall smooth; aperture radiate.

Length 0.60–1.25 mm.; breadth 0.45–0.90 mm.; thickness 0.30–0.60 mm.

Globulina consobrina is closely related to *Globulina rotundata*, but its initial end is acuminate.

Distribution.—Rather common in European young Tertiary deposits. Fornasini's figured specimen was obtained from the Pliocene of Siena. We have specimens from the following localities:

Miocene.—Hungary, Tortonian, Varpolata. Austria, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, Vienna. France. St. Avit, near Mont de Marsan, Helvetian, Moulin de Minoy, Salles; Burdigalien inferieur, Moulin de l'Eglise, Saucats.

GLOBULINA MÜNSTERI (Reuss)

Plate 22, figures 3 *a–c*

Polymorphina münsteri Reuss, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 249, pl.. 8, fig. 80.

Polymorphina ovulum Reuss, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 250, pl. 8, fig. 83.

Polymorphina amygdaloides Reuss, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 250, pl. 8, fig. 84.—Burrows and Holland, Proc. Geol. Assoc., vol. 15, 1897, p. 46, pl. 2, fig. 18.

Polymorphina communis d'Orbigny var. *etrusca* Fornasini, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 9, 1900–1902, p. 70, fig. 23 (in text).

Polymorphina obtusa d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 1.—Fornasini, Boll. Soc. Geol. Ital., vol. 19, 1900, p. 146, fig. 4 (in text).

Polymorphina gibba Burrows, Sherborn, and Bailey, Journ. Roy. Micr. Soc., 1890, p. 561, pl. 11, fig. 13.

Test ovate to oval, more or less compressed, rounded at the base; chambers rather elongated, embracing, arranged in a nearly overlapping, triserial series; sutures not depressed, generally distinct; wall smooth, often with fistulose tubes; aperture radiate.

Length 0.45–0.70 mm.; breadth 0.25–0.50 mm.; thickness 0.18–0.38 mm.

In 1856 Reuss described three species of compressed and o al *Globulina* from the German Oligocene. They are *Polymorphina münsteri, P. amygdaloides*, and *P. ovulum*, of which the second is the

most compressed, but does not show any difference in its arrangement of chambers from the first. Of the last species, two different specimens are figured from the same side, and the figures show no important difference from the other two species.

Polymorphina communis var. *etrusca* Fornasini has an ovate test with broadly rounded base, but the arrangement of its chambers and the compressed test are the same as those of the present species, and it can be safely put in the synonymy.

Polymorphina obtusa d'Orbigny, figured by Fornasini, has almost the same appearance as Fornasini's *Polymorphina etrusca*, and we have no reason to separate them. On the other hand, d'Orbigny's species figured by Terquem is from the figure a 4-chambered specimen, having rather rounded chambers arranged in an alternating almost uniserial series. It seems to be quite distinct from the specimen figured by Fornasini. According to Terquem's description, his *Polymorphina obtusa* has a compressed test. In this point it differs from *Pyrulina*. It is impossible for us to place his species in any known species.

Distribution.—Our material ranges from Miocene to Upper Eocene as follows:

Miocene.—France, Helvetian, Pontlevoy. Hungary, Tortonian, Varpolata. Austria, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, Vienna. Germany, Ortenburg.

Oligocene.—Germany, Ahnatal, near Cassel. Mexico, Tampico-Panuco Railroad, kilometer post 20.9, Vera Cruz; near Cuesta Blanca, Zacamixtle, Vera Cruz.

Eocene.—France, Bartonian, Le Guepelle (Seine et Oise). United States, Alabama, Jacksonian, road from Perdue Hill to Claiborne, Munroe County; on small stream entering Conecuh River, 1 mile east of Beck, Covington County; east bank Sepulga River, 3½ miles northeast of Brooklyn, Conecuh County, Ga., on old Waynesboro Road, 5 miles north of Millen, Jenkins County.

GLOBULINA ROTUNDATA (Bornemann)

Plate 21, figures 3, 4

Guttulina rotundata Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 346, pl. 18, fig. 3.

Polymorphina rotundata H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 234, pl. 40, figs. 19 *a–e;* Woodcuts *k, l, m.*—H. B. Brady, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 435, pl. 20, figs. 6 *a, b.*—Sidebottom, Mem. Proc. Manchester Lit. Philos. Soc., vol. 151, No. 9, 1907, p. 11, pl. 2, fig. 18.

Guttulina fracta Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 344, pl. 17, fig. 4.

Guttulina incurva Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 345, pl. 17, fig. 6.

Guttulina globosa BORNEMANN, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 346, pl. 18, fig. 1.

Guttulina obtusa BORNEMANN, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 346, pl. 18, fig. 2.

Guttulina turgida REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 246, pl. 6, fig. 66.

Polymorphina turgida REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 487.—v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 28, figs. 6–10; pl. 29, figs. 1–5.

Globulina subalpina GÜMBEL, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 10, 1870, p. 646, pl. 2, fig. 80 *a*, *b*.

Polymorphina subcruciata TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 140, pl. 14 (22), figs. 26, 27.

Test ellipsoidal or ovoid to cylindrical, rounded at the base, slightly produced at the apertural end; chambers rounded, almost as long as broad, arranged in a nearly triserial series, each succeeding chamber removed much farther from the base, rarely becoming almost uniserial in the last chamber; sutures but little depressed, generally distinct; wall smooth, thick, often with fistulose tubes; aperture radiate.

Length 0.45–0.90 mm.; breadth 0.30–0.60 mm.; thickness 0.25–0.55 mm.

In their monograph of the genus *Polymorphina*, H. B. Brady, Parker, and Jones united many compact, oval species of the Polymorphinidae described by Bornemann in 1855 from the Septaria clay of Hermsdorf under the name *Polymorphina rotundata*. This was selected by them because it represented the best-developed specimen in spite of the earliest name among their synonyms, which is *Guttulina fracta*.

The present species is almost circular in section; therefore its figures show more or less differences according to the position of the specimen drawn. For example, Bornemann's *Guttulina obtusa*, judging from his figures, has almost the same cylindrical test as his *G. rotundata*, but in its sutures appears to be quite different from the latter. Bornemann's *Guttulina globosa* (1855), although it has the test more inflated at the base, presents the same feature of the sutures as his *Guttulina obtusa*, so far as shown by the figures. The difference of shape can be considered to be within the range of usual variation. Terquem's *Polymorphina subcruciata* and d'Orbigny's *Polymorphina pupa*, figured by Fornasini, are also related to the present group.

Reuss's *Guttulina turgida* from the Oligocene of Luithorst has the later chambers each much farther removed from the base as in *Globulina rotundata*, though it has almost an oval test.

The present species as above described has a tendency to add the later chambers in a more or less uniserial series, as is shown in Bornemann's *Guttulina fracta* and *G. incurva*, of which the latter appears to

be an abnormal form, because its last chamber is added on the same side as the former one. Such an abnormality often occurs in the Polymorphinidae.

Distribution.—Fairly common in the various European Tertiary deposits, although it occurs in other continents and as a Recent species.

Recent.—Tripoli.

Pliocene.—England, Crag of Sutton.

Miocene.—France, Helvetian, Pontlevoy; Moulin de Minoy, Salles; Aquitanian superieur, St. Avit, near Mont de Marson; Burdigalien superieur, Merignac; Burdigalien moyen, Le Coquillat, Leognan. Hungary, Tortonian, Varpolata (very abundant); Lapugy. Austria, Perchtoldsdorf, near Vienna. United States, Choctawhatchee formation, 1 mile east of Red Bay, Walton County, Fla.

Oligocene.—Germany, Ahnatal, near Cassel; Hermsdorf, near Berlin; Hildesheimer Wald, Dickholzen; Doberg, near Bünde.

Eocene.—England, Bracklesham bed XVIII, White Cliff Bay, Isle of Wight; Thanetian, Pegwell Bay. France, Lutetien, Grignon. Belgium, lower Eocene, Wansin. United States, Cooper marl, dump heap from Charleston Aqueduct tunnel, 1 mile west of Givhans, Dorchester County, S. C.; pit on United States Highway No. 17, three-fourths mile west of Moncks Corner, Berkeley County, S. C.

GLOBULINA ROTUNDATA (Bornemann) var. PYRULA (Fornasini)

Plate 15, figures 5 *a–c*

Polymorphina rotundata BORNEMANN var. *pyrula* FORNASINI, Mem. Istit. Bologna Accad. Sci., ser., vol. 9, 1900–1902, p. 67, fig. 19 (in text).

Variety differing from the typical in having spines at the initial end.

We can not find any specimen like the present variety in our collection; therefore we have copied Fornasini's figures here.

GLOBULINA TRISERIALIS Cushman and Ozawa, new species

Plate 22, figures 1, 2

Test globular to oval, more or less acute toward the initial end, circular in cross section; chambers numerous, rounded, much embracing, arranged in an almost triserial series, each succeeding chamber farther removed from the base; sutures not depressed, often obscured; wall smooth, but often the last-formed chamber finely spinose; aperture radiate.

Length 0.40–0.70 mm.; breadth 0.33–0.45 mm.; thickness 0.28–0.35 mm.

Holotype.—(Cushman Coll. No. 11653.) From the Miocene, Helvetien, Salles, Moulin de Minoy, France.

The present *Globulina* is a many chambered species. Its chambers are rounded and short, each succeeding one is removed from the base, and accordingly the test is becoming more or less oval and approaching *Pyrulina*.

Distribution.—Found only in the Miocene near Bordeaux. Besides the type locality, it occurs in the Burdigalien inferieur, Moulin de l'Eglise, Saucats, France.

GLOBULINA species(?)

Plate 22, figures 4 *a*, *b*

This peculiar form is figured here for reference. It is Recent from *Porcupine* Station 16 off the British Isles.

Genus PSEUDOPOLYMORPHINA Cushman and Ozawa, 1928

PSEUDOPOLYMORPHINA LIGUA (Roemer)

Plate 22, figures 5, 6

Polymorphina ligua ROEMER, Neues Jahrb. für Min. etc., 1838, p. 385, pl. 3, fig. 25.

Polymorphina compressa D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 233, pl. 12, figs. 32–34.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 227, pl. 40, figs. 12 *a–f*.—SCHLUMBERGER, Feuille des Jeunes Nat., vol. 12, 1881, pl. 1, fig. 16.—BAGG, U. S. Geol. Survey, Bull. 513, 1912, p. 69, pl. 20, figs. 1–9, 19–21; pl. 21, figs. 9–11.

Polymorphina subcompressa D'ORBIGNY, Prodrome de Paleont., vol. 3, 1852, p. 159, No. 2976.

Guttulina elongata KARRER, Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 448, pl. 2, fig. 3.

Polymorphina amoena KARRER, Abhandl. k. k. geol. Reichs., vol. 9, 1877, p. 385, pl. 16 *b*, fig. 45.

Polymorphina inequalis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 4.—FORNASINI, Boll. Soc. Geol. Ital., vol. 19, 1900, p. 142, fig. 3 (in text).

Test oblong, inequilateral, compressed; chambers much longer than wide, slightly inflated, arranged at the start in a quinqueloculine series, becoming biserial later, each succeeding chamber much farther from the base; sutures slightly depressed, distinct; wall smooth, rather thick; aperture radiate.

Length 0.65–2.10 mm.; breadth 0.42–0.80 mm.; thickness 0.28–0.50 mm.

Polymorphina ligua has long been neglected by later authors. Reuss in 1864 compared the species with *Polymorphina acuta* and said that they may be identical but *Polymorphina acuta* is not a *Polymorphina*, but a *Virgulina* (examined by Ozawa). H. B. Brady, Parker, and Jones put it in the synonymy of *Polymorphina complanata*, with doubt.

We examined material from the type locality, Oligocene of Cassel, and found specimens like the figure given by Roemer. Our specimen resembles *Polymorphina compressa* d'Orbigny, from the Vienna

Basin (the specific name was changed by d'Orbigny to *subcompressa* because it is preoccupied by Phillips), and we can find no reason for separating them.

Holotype specimens of *Guttulina elongata* and *Polymorphina amoena*, both described by Karrer from Nussdorf in the Vienna Basin, were examined by Ozawa, who found that they are nothing but *Polymorphina subcompressa* d'Orbigny. They should be included in *Pseudopolymorphina ligua*.

The original specimen of *Polymorphia compressa* is lost and the paratype specimens are mostly *Virgulina* with one specimen resembling the figure of *Polymorphina compressa*.

Polymorphina inequalis d'Orbigny, figured by Fornasini in 1900, has a rather broad test, but it is not different from the present species in other respects.

Distribution.—*Pseudopolymorphina ligua* is rare in the Oligocene, but common in various Miocene and Pliocene deposits in Europe. We have specimens from the following localities:

Pliocene.—Belgium, Crag noir, Antwerp. England, Crag, Sutton; Aldeburg, Suffolk.

Miocene.—Austria, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna.

Oligocene.—Germany, Ahnatal, near Cassel.

PSEUDOPOLYMORPHINA NOVANGLIAE (Cushman)

Plate 23, figures 1, 2

Polymorphina lactea (Walker and Jacob) var. *novangliae* Cushman, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 146, pl. 39, figs. 6–8.

Test elongated, more or less compressed, tapering toward the base, either acute or obtuse at the initial end; chambers longer than broad, embracing, arranged at first in a nearly contraclockwise, quinqueloculine series, later becoming more or less biserial; sutures but little depressed, generally distinct; wall smooth, often with fistulose tubes at the apertural end; aperture radiate.

Length 1.15–1.95 mm.; breadth 0.55–0.65 mm.; thickness 0.20–0.35 mm.

The present species differs from *Pseudopolymorphina ligua* in the rounded chambers and slightly depressed sutures which give the test a more compact appearance. Its more or less quinqueloculine arrangement of the early chambers is always contraclockwise instead of clockwise, as in *P. ligua*. Its apertural end is often covered by fistulose tubes. Williamson's *Polymorphina lactea* var. *acuminata* is an elongated test having an acute initial end, and the arrangement of chambers is similar to that of the present species and is closely related to it.

Distribution.—This species is apparently confined to the cold water of the American side of the Atlantic, very abundant off the New England coast. Our specimens are from the following localities: Bay on east coast (south of Black Whale Harbor, Hudson Bay), 10 fathoms; Gaspé Bay, 10–40 fathoms; Cobscook Bay; off Trials Island, Eastport, Me.; between Crotch and Stave Islands, Casco Bay, Me., 7 fathoms; shore sand, Coffins Beach, Annisquam, Mass.; beach sand, Newport, R. I.; one broken specimen, which may be this species, is from off Iceland. It occurs also at *Albatross* stations in cold water off the New England coast.

PSEUDOPOLYMORPHINA SUBOBLONGA Cushamn and Ozawa, new species

Plate 23, figures 3 *a–c*

Test elongated, the greatest breadth in the upper half, obtuse at the base, acute at the apertural end; chambers twice as long as wide, inflated, slightly overlapping, arranged at first in a quinqueloculine series, later becoming biserial; sutures depressed, distinct; wall smooth, rather thick; aperture radiate.

Length 0.90–1.30 mm.; breadth 0.35–0.60 mm.; thickness 0.20–0.35 mm.

Holotype.—(Cushman Coll. No. 11663.) From upper Pliocene, Okuwa, Province of Kaga, Japan. Paratypes in collection of Geological Institute, Imperial University of Tokyo, Japan.

The present species represents an intermediate form between *Guttulina* and *Pseudopolymorphina*, and the arrangement of chambers is not very definite, but generally begins with a quinqueloculine series which becomes more or less biserial later. It differs from *Pseudopolymorphina ligua* of the European Tertiary in its less regular biserial arrangement of rather short chambers and depressed sutures.

Distribution.—It occurs as an upper Pliocene fossil in Japan and as a living species off the coast. We have specimens from the following localities:

Recent.—*Albatross* D4807, off Cape Tsiuka, Japan, 44 fathoms.

Upper Pliocene.—Okuwa, Province of Kaga, and Natsukawa, Province of Echigo, Japan.

PSEUDOPOLYMORPHINA SUBOBLONGA var. JUGOSA Cushman and Ozawa, new variety

Plate 23, figures 4 *a*, *b*

Variety differing from the typical form in its surface ornamentation, consisting of a few low longitudinal costae running from the initial end, obscured near the aperture.

Length of holotype 1.05 mm.; breadth 0.30 mm.; thickness 0.25 mm.

Holotype of variety.—(Cushman Coll. No. 11665.) From Kabama (Sea of Japan), Province of Echizen, Japan. Paratypes in collection of Geological Institute, Imperial University of Tokyo, Japan.

It does not occur with the typical form and is only found as a Recent form.

We have a number of specimens from the shore sand at Kobama (Sea of Japan), in Province of Echizen. There is also a Recent specimen from *Albatross* Station D5311 in 88 fathoms, China Sea, off Hongkong.

PSEUDOPOLYMORPHINA STRIATA (Bagg)

Plate 23, figures 5 *a–c*

Polymorphina compressa var. *striata* BAGG, Maryland Geol. Survey, Miocene, 1904, p. 476, pl. 133, fig. 2.

Polymorphina regina BAGG, Maryland Geol. Survey, Miocene, 1904, p. 478, pl. 133, fig. 7.

Polymorphina compressa BAGG, Maryland Geol. Survey, Miocene, 1904, p. 476, pl. 133, fig. 1.

Test compressed, elongated, base rounded; chambers longer than broad, not much embracing, arranged at first in a nearly contraclockwise, quinqueloculine series, later becoming regularly biserial with the chambers alternating; sutures slightly depressed, distinct; wall marked with fine longitudinal costae, typically covering the entire test; aperture radiate.

Adult specimen, length 1.30–1.60 mm.; breadth 0.42–0.50 mm.; thickness 0.18–0.20 mm.

The present species is different from d'Orbigny's *Polymorphina compressa* in its arrangement of the early chambers, which is the same as that of *P. novangliae*. From *P. novangliae* it differs in the depressed sutures and more compressed test. The ornamentation of the wall of the test is not always constant, and often a few of the last chambers are without striations.

Distribution.—We have abundant specimens of this species from the Miocene, Choptank formation, 2½ miles below Governor Run, Chesapeake Bay, Md.; from 1 mile below Governor Run, and from Point of Rocks, about 1½ miles below Flag Pond, Chesapeake Bay, Md.

PSEUDOPOLYMORPHINA SOLDANII (d'Orbigny)

Plate 23, figures 6–8

Orthoceratia tuberosa SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, p. 99, pl., fig. 107 *n n*.

Polymorphina soldanii D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 12.—FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 8, 1899–1900 (1900), p. 388, fig. 38 (in text).—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 235, pl. 40, fig. 20.—BAGG, U. S. Geol. Survey, Bull. 513, 1912, p. 74, pl. 19, fig. 8.

Polymorphina oblonga ROEMER, Neues Jahrb. f. Min. etc., 1838, p. 386, pl. 3, fig. 34.

Globulina subalpina GÜMBEL, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 10, 1868 (1870), p. 646, pl. 2, figs. 80 *a. b.*

Polymorphina obovata GRZYBOWSKI, Pod. Dukli. W. Krakowie, 1894, p. 117, pl. 2, fig. 23.

Polymorphina proteus BEISSEL (part), Abhandl. preuss. geol. Landes. Aus., vol. 3, 1891, p. 59, pl. 11, figs. 4–7 (not 1–3, 8–56; pl. 12, figs. 1–16).

Test elongate, more or less compressed, oblong, rounded at both ends; chambers rounded to oval, arranged at first in a nearly triserial series, later becoming almost biserial; sutures depressed, distinct; wall thick, smooth, often with fistulose tubes; aperture radiate.

Length 1.05–1.50 mm.; breadth 0.50–0.80 mm.; thickness 0.28–0.40 mm.

In their monograph of *Polymorphina*, H. B. Brady, Parker, and Jones placed *Polymorphina soldanii* d'Orbigny, *Polymorphina oblonga* d'Orbigny (not Roemer), and *Polymorphina uvaeformis* together, but in the *Challenger* report Brady separated d'Orbigny's *P. oblonga* from *P. soldanii* without giving any notes.

Pseudopolymorphina soldanii is undoubtedly related to *Guttulina oblonga* d'Orbigny. From such a form it might be derived by losing its quinqueloculine arrangement of chambers and the chambers becoming shorter and rounded. The present species seems to be very variable in its form. The figures given by Fornasini are much broader than the figures copied by Brady, Parker, and Jones, though both figures present the same general characters.

Polymorphina oblonga Roemer and *P. obovata* Grzybowski are apparently the same, judged by the figures, and both have compressed tests consisting of rather short, rounded chambers arranged in a somewhat biserial series. After having examined German Oligocene material from several localities, among which there are specimens resembling *Polymorphina oblonga* Roemer, as well as *Pseudopolymorphina soldanii*, we are convinced that they should be united.

Figures 4–7 in plate 11 of *Polymorphina proteus* Beissel, show a biserial arrangement of short chambers and are very close to the present species.

We have several Upper Cretaceous specimens of *Pseudopolymorphina soldanii* from Maastricht, which are almost the same as Beissel's figures above mentioned.

Polymorphina subalpina Gümbel is also included in the present species with some doubts.

Distribution.—There are specimens in our collection from the following localities:

Pliocene.—England, Crag, Sutton.

Miocene.—France, Helvetian, Pontlevoy; Moulin du Minoy, Salles; Burdigalien inferieur, Le Coquillat, Leognan; Moulin de l'Eglise, Saucats.

Oligocene.—Germany, Ahnatal, near Cassel.

Cretaceous.—Holland, Maastricht (?).

PSEUDOPOLYMORPHINA HANZAWAI Cushman and Ozawa

Plate 24, figures 1 *a*, *b*

Pseudopolymorphina hanzawai CUSHMAN and OZAWA, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 16, pl. 1, fig. 15; Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 69, pl. 13, fig. 4; pl. 14, fig. 11; pl. 15, figs. 3, 4.

Test large, about twice as long as broad, the later portion somewhat compressed and tending to become biserial in the last chambers, greatest breadth above the middle, broadly rounded at the base; chambers numerous, only slightly longer than broad, arranged in an elongate, closed, sigmoid series becoming biserial; sutures distinct, but very slightly depressed; wall thick, smooth, translucent; aperture radiate, terminal.

Measurements of the figured specimens: 2.25–2.40 mm.; breadth 1.10–1.26 mm.; thickness 0.85 mm.

This species differs from *Guttulina spicaeformis* (Roemer) in its biseral form in the adult and in the very much larger size. It is more closely related to *Guttulina yabei* from which it is probably derived by the addition of the biserial character.

Distribution.—The types of this species are from the Pliocene of Sawane, Island of Sado, Japan. It also occurs in the Pliocene of Okuwa, Province of Kaga, Japan. We have somewhat similar specimens from *Albatross* Station D2416 in 276 fathoms off the Carolina coast and a single specimen which much resembles this from the Miocene, Burdigalien moyen, of Le Coquillat, Leognan, France.

PSEUDOPOLYMORPHINA ATLANTICA Cushman and Ozawa, new species

Plate 24, figures 2 *a*, *b*

Polymorphina compressa FLINT (not d'Orbigny), U. S. Nat. Mus., Rept., 1897 (1899), p. 319, pl. 67, fig. 3.

Test ovate (young) to fusiform (adult), obtuse at the base, acute at the apertural end, slightly compressed; chambers nearly clavate, not much overlapping, arranged in a nearly triserial series at the start, becoming biserial later; sutures depressed, distinct; wall smooth, thick; aperture radiate.

Figured specimen, length 1.50 mm.; breadth 0.75 mm.; thickness 0.32 mm.

Holotype.—(U. S. Nat. Mus. Coll. No. 20955.) From *Albatross* dredgings off the eastern coast of the United States.

Flint's *Polymorphina compressa*, described in 1897, is quite different from d'Orbigny's species, figured in 1846, from the Vienna Basin in its broader test and depressed sutures, and its earlier chambers are more rounded and inflated and the sutures are generally much oblique. Our specimens examined are those described by Flint.

Distribution.—Only known off the Atlantic coast of the United States, 88–440 fathoms. Doctor Flint selected a set of specimens from several stations along the Atlantic coast, but did not keep separate those from the different stations, and so the exact station can not be given.

PSEUDOPOLYMORPHINA PHALEROPEI Cushman and Ozawa, new species

Plate 24, figures 3 *a*, *b*

Test oblong, but little compressed, rounded at the base; periphery broadly rounded; chambers inflated, as long as wide, slightly embracing, arranged in a nearly biserial series; sutures depressed, very distinct; wall thin, smooth, transparent; aperture radiate.

Length 0.70 mm.; breadth 0.42 mm.; thickness 0.30 mm.

Holotype.—(Cushman Coll. No. 2237.) From the Atlantic coast of Massachusetts in the Woods Hole region, dredged by the United States fisheries steamer *Phalerope*.

Its round and inflated chambers separated by the deep sutures are the most important character of the species, and there is no other species of the genus which is likely to be confused with the present one.

PSEUDOPOLYMORPHINA PARVA (Clodius)

Plate 24, figures 4 *a*, *b*

Polymorphina (*Guttulina*) *parva* CLODIUS, Archiv. Ver. Fremde Nat. Mecklenburg, 75 Jahrg, 1922, p. 127, pl. 1, fig. 10 *a*, *b*.

Test elongate, subfusiform, more or less compressed; chambers spherical, arranged in a quinqueloculine series, becoming biserial later; sutures much depressed, distinct; wall smooth, thick; aperture radiate.

Pseudopolymorphina parva is unique in its spherical chambers separated by very deep sutures.

We have no specimen of the present species.

PSEUDOPOLYMORPHINA DOANEI (Galloway and Wissler)

Plate 24, figures 5 *a*, *b*

Polymorphina doanei GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 54, pl. 9, fig. 8.

Bulimina contraria BAGG (not Reuss), Bull. 513, U. S. Geol. Survey, 1912, p. 37, pl. 9, fig. 2.

Polymorphina nodosaria BAGG, Bull. 513, U. S. Geol. Survey, 1912, p. 71, pl. 21, figs. 2, 3 (not fig. 1).

Test but little compressed, elongated, the greatest breadth in the upper half, gradually tapering toward the base, initial end obtuse; chambers rounded, but little embracing, arranged at first in a quinqueloculine series, abruptly becoming biserial, in full grown specimens the later ones tending to become somewhat uniserial, each succeeding chamber very much farther removed from the base; sutures much depressed, very distinct; wall thick, smooth; aperture radiate.

Length of figured specimen 2.20 mm.; breadth 0.65 mm.; thickness 0.50 mm.

In general appearance this species is almost identical with *Pseudopolymorphina parva* excepting its slightly more rounded initial end. It may be possible that the present species is the megalospheric form of *P. parva*. However, as we have no European or topotype specimens representing *P. parva*, we can not definitely say that they are the same species. Therefore until we examine the original specimen *P. doanei* is kept as a good species and is described here.

It is only known from the Pleistocene and Pliocene of California, in which it is rather common.

Galloway and Wissler described it from the lower bed at the D. M. S. and B. quarry, and noted its occurrence in the Pliocene of Timms Point, San Pedro, Calif. We have a series of specimens from both of these localities.

PSEUDOPOLYMORPHINA DECORA (Reuss)

Plate 24, figures 6–8

Polymorphina decora Reuss, Bull. Acad. Roy. Sci. Belg., ser. 2, vol. 15, 1863, p. 152, pl. 3, fig. 41.

Polymorphina texana Cushman and Applin, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 173, pl. 9, figs. 1, 2.

Test elongated, more or less compressed, periphery rounded, sides nearly parallel; chambers somewhat longer than wide, slightly embracing, alternating, arranged in a nearly biserial series from the start; sutures not depressed, distinct; wall smooth; aperture radiate.

Length 0.75–1.10 mm.; breadth 0.32–0.36 mm.; thickness 0.15–0.18 mm.

Polymorphina decora, figured by Reuss from the Crag of Antwerp, is evidently a young, few-chambered specimen. An adult many-chambered specimen is much elongated with the sides almost parallel.

It resembles *Pseudopolymorphina spatulata* (Terquem) in its general appearance, but the latter has a thicker test with rather inflated chambers and slightly depressed sutures. These differences are not very distinctive, and there are transitional forms.

Distribution.—Rather common in the Miocene deposits near Bordeaux. Somewhat similar specimens occur in the Eocene of France.

Miocene.—France, Aquitanian superieur, near Mont de Marsan, St. Avit; Burdigalien superieur, Pont Pourquet, Saucats; Burdigalien inferieur, St. Paul de Dax, Dax; Le Coquillat, Leognan; Moulin de l'Eglise, Saucats.

Eocene.—France, Calcaire grossier, Beauves; Lutetien, Chaussy.

PSEUDOPOLYMORPHINA DUMBLEI (Cushman and Applin)

Plate 25, figures 1 *a*, *b*

Polymorphina compressa D'ORBIGNY var. *dumblei* CUSHMAN and APPLIN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 173, pl. 9, figs. 4, 5.

Test compressed, elongated, obtuse at the base, more or less acute at the apertural end; chambers slightly longer than wide, more or less compressed, much embracing, arranged at first in a nearly triserial series becoming biserial later; sutures but little depressed, distinct; wall smooth; aperture radiate.

Length 0.70–1.10 mm.; breadth 0.35–0.40 mm.; thickness 0.16–0.20 mm.

The present species is an ally of *Pseudopolymorphina decora* of the European Tertiary, and it is often difficult to separate them. The important difference is the shape of chambers, which in the present species are shorter than those of the European species.

Polymorphina texana is a few-chambered species representing a young stage of *P. decora.*

Distribution.—This was originally described as a variety of *P. compressa* but is not related to that species. The types are from the upper Eocene of Texas. It is found in the upper Eocene of Texas, Alabama, and Georgia as well as in samples from Mexico referred to the Alazan clays. Single specimens from the Miocene and the Claiborne are close to this species as well as a few from the Midway, but more material will give added light on their exact relationships. We have no European material to place with this.

Our specimens are from the following localities:

Miocene.—Florida, Choctawhatchee marl, 1 mile east of Red Bay.

Eocene.—Jacksonian, Bridge Creek, 1½ miles above Angelina River, Texas; Powells Landing, east bank of Sepulga River, sec. 35, T. 4 N., R. 13 E., Covington County, Ala.; Conecuh River at Beck, Covington County, Ala.; Cocoa sand, Keysers Hill, one-fourth mile west of Water Valley, Choctaw County, Ala. Jackson, on old Waynesboro Road, 5 miles north of Millen, Jenkins County, Ga.; Rich Hill, Crawford County, Ga. Mexico, Alazan shale, Rio Buena Vista, 9.8 kilometers upstream from Tumbadero, Vera Cruz; Rio Tuxpam, south side just above Agua Nacida, Vera Cruz, Mexico.

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PSEUDOPOLYMORPHINA OKUWAENSIS Cushman and Ozawa

Plate 25, figures 2, 3

Pseudopolymorphina compressa D'ORBIGNY var. *okuwaensis* CUSHMAN and OZAWA, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 72, pl. 13, fig. 7; pl. 15, figs. 8, 9.

Test compressed, elongated, rounded at the base, acute at the apertural end, margin nearly parallel; chambers slightly compressed, as long as wide, slightly embracing, arranged at first in a nearly triserial series (the microspheric form) later becoming biserial; sutures generally slightly depressed, distinct; wall smooth, thick; aperture radiate.

Length 0.85–1.10 mm.; breadth 0.36–0.50 mm.; thickness 0.15–0.27 mm.

We formerly described this as a variety of *Pseudopolymorphina compressa*, but it is very distinct from the latter in its much shorter chambers. It may be compared with the European *Pseudopolymorphina decora* and American Eocene *P. dumblei*, with which it may be closely related. Its distinction from these two is in the round short chambers, but there are intermediate forms among the above three species.

Distribution.—It is quite abundant in the Japanese Pliocene as well as now living in the same general region.

Recent.—Kobama, Inland Sea of Japan, Province of Echizen, Japan.

Upper Pliocene.—Okuwa, Province of Kaga, Japan.

PSEUDOPOLYMORPHINA ISHIKAWAENSIS Cushman and Ozawa

Plate 25, figures 4, 6

Pseudopolymorphina ishikawaensis CUSHMAN and OZAWA, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 70, pl. 13, fig. 5; pl. 15, fig. 5

Test much elongated, somewhat compressed, but the periphery broadly rounded, sides in the adult portion nearly parallel; chambers numerous, biserial, somewhat inflated, only slightly overlapping; sutures somewhat limbate, not depressed, distinct; wall thick, smooth; aperture radiate.

Length 2.30–2.70 mm.; breadth 0.70–0.78 mm.; thickness 0–48–0.52 mm.

The elongate and narrow test consisting of oval chambers which are arranged in an almost entirely biserial series will distinguish it from any other species of the genus.

Distribution.—The types of this species are from the Upper Pliocene of Okuwa, Province of Kaga, Japan. It also occurs in the upper Pliocene of Natsukawa, Province of Echigo, and Dainichi, Province of Totomi, Japan. The same species occurs in the Upper Miocene of Kumonyo, Province of Totomi, Japan.

PSEUDOPOLYMORPHINA ZEUSCHNERI (Reuss)

Plate 25, figures 5 *a–c*

Polymorphina zeuschneri REUSS, Sitz. Akad. Wiss. Wien, vol. 55, pt. 1, 1867, p. 90, pl. 4, fig. 1.

Test oblong to more or less fusiform, compressed, broadest at the upper half, rather acute at the initial end; chambers rounded, compressed, arranged in a biserial series; sutures depressed but little, distinct; wall smooth; aperture radiate.

Length of figured specimen 0.80 mm; breadth 0.50 mm.; thickness 0.30 mm.

The specimen described by Reuss comes from "Salzthon" and "Steinsalz" in Galicia. We have a specimen from the Miocene of Varpolata in Hungary which is not much different in its foraminiferal fauna from the formation in Galicia.

Polymorphina consecta d'Orbigny, figured later by Fornasini, is from the Miocene of Dax and shows a close resemblance to the present species.

PSEUDOPOLYMORPHINA INDICA (Cushman)

Plate 25, figures 7 *a*, *b*

Polymorphina problema D'ORBIGNY var. *indica* CUSHMAN, Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 265, pl. 52, figs. 1, 2; pl. 53, figs. 1 *a*, *b*.

Test large, broad, oblong, but little compressed; chambers inflated, rounded, arranged at first in a quinqueloculine series, later becoming more or less biserial; each succeeding chamber removed farther from the base; sutures much depressed, distinct; wall thick, that of earlier chambers and the posterior half of the later ones with fine longitudinal costae; aperture radiate.

Maximum length 2.50 mm.; breadth 1.60 mm.; thickness 1.00 mm.

The present species is close to *Guttulina regina* from which it is evidently derived by losing the quinqueloculine arrangement of chambers. The surface ornamentation is not definite, and that of the later chambers is often obscured.

Type specimen (Cat. No. 16056, U.S.N.M.) from *Albatross* Station D5579, off Sibuko Bay, Borneo, in 75 fathoms (320 m.).

Distribution.—We have three specimens from the type locality. The species also occurs at the neighboring *Albatross* Station D5580, off Sibuko Bay, in 162 fathoms. A single specimen from off Amino, Japan, completes the known distribution.

PSEUDOPOLYMORPHINA INDICA (Cushman) var. JAPONICA Cushman and Ozawa

Plate 26, figures 1, 2

Pseudopolymorphina indica (CUSHMAN) var. *japonica* CUSHMAN and OZAWA, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 71, pl. 13, fig. 6; pl. 15, fig. 6.
Polymorphina costata ALLIX, Feuille des Jeunes Naturalistes, vol. 43, 1913, p. 41, fig. 6 (in text) (?).

Variety differing from the typical form in having the later chambers more regularly biserial and accordingly the test more compressed.

Length of holotype 3.10 mm.; breadth 1.87 mm.; thickness 0.81 mm.

Polymorphina costata Allix reported from the Miocene of Touraine appears to be a young specimen of the present species. We have a specimen like Allix's figure from the Miocene of Pontlevoy. This specimen is fistulose and resembles the young stage of the megalospheric form of *Pseudopolymorphina indica* var. *japonica*. We can not say definitely whether or not Allix's species is identical with the present variety. The specific name *costata* of Allix's species is preoccupied by Egger in 1856, and therefore the present varietal name is not disturbed by his species.

The types of this variety are from the Pliocene of Sawane, island of Sado, Japan. The specimen figured here is from *Albatross* Station D4807, 44 fathoms, off Cape Tsiuka, Japan.

PSEUDOPOLYMORPHINA RUTILA (Cushman)

Plate 26, figures 3 *a*, *b*

Polymorphina regina H. B. Brady, Parker, and Jones var. *rutila* Cushman, U. S. Geol. Survey Prof. Paper 133, 1923, p. 34, pl. 5, figs. 7, 8.

Test compressed, elongate, fusiform, with a strong spine at the base; chambers more or less elongated, not much embracing, alternating; sutures more or less depressed, distinct; wall marked with a few strong, longitudinal costae; aperture radiate.

Maximum length 1.30 mm.; breadth 0.22 mm.; thickness 0.14 mm.

This species is undoubtedly derived from *Guttulina costulata* Cushman by greatly reducing the quinqueloculine arrangement of chambers in the young. Like *Guttulina costulata*, it is conspicuous by its surface ornamentation.

Distribution.—This species was described from the lower Oligocene, the Byram calcareous marl at Leaf River, Miss. It occurs also in the Byram marl at Byram, Miss.

PSEUDOPOLYMORPHINA RUTILA (Cushman) var. PARRI Cushman and Ozawa, new variety

Variety differing from the typical in the somewhat broader test and coarser costae.

Holotype of variety.—(Cushman Coll. No. 7833.) From Miocene, Janjukian, soapy clay bed in Polyzoal limestone, Danger Point, Torquay, Victoria, Australia.

This variety is named for Mr. W. J. Parr, of Australia, whose interesting collections have afforded us opportunity to study many of the Australian forms.

PSEUDOPOLYMORPHINA PAUCICOSTATA Cushman and Ozawa, new species

Plate 26, figures 4 *a*, *b*

Test compressed, elongated, greatest breadth in the upper half, gradually tapering toward the initial end; chambers more or less compressed, arranged in a biserial series; sutures slightly depressed, distinct; wall thick, ornamented by a few low longitudinal costae, which are often obscured; aperture radiate.

Length of holotype 1.20 mm.; breadth 0.50 mm.

Holotype.—(Cat. No. 371261, U.S.N.M.) From Midway Eocene, U. S. G. S. Station 1/797, on west or downthrow side of fault, 2 miles northwest of Lone Oak, Hunt County, Texas.

Its more or less lance-shaped test and coarse longitudinal ornamentation are the important characteristics to separate the present species from any others of the genus.

PSEUDOPOLYMORPHINA OBSCURICOSTATA (Galloway and Wissler) (?)

Plate 39, figure 6

Polymorphina obscuricostata GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 56, pl. 9, fig. 12 (*P. obscurocostata* on explanation of plate).

Test compressed, irregularly oval in side view; chambers few, compressed, longer than wide, not much embracing, arranged in a biserial series; sutures slightly depressed, distinct; wall ornamented with about six low obscure costae to a side, extending from the rounded initial end about two-thirds of the way to the aperture; aperture radiate.

Length of the specimen 0.22 mm.; width 0.13 mm.; thickness 0.05 mm.

The present species is undoubtedly a young specimen of an ornamented *Pseudopolymorphina*. It resembles *Pseudopolymorphina indica* and its variety, but the chambers are more elongated and the costae are fewer; therefore we keep it as a good species.

The above description is mainly copied from the original.

Distribution.—Galloway and Wissler described the species from a single specimen which is from the Pleistocene, middle bed, in the D. M. S. and B. quarry, near Lomita, Palos Verdes Hills, Calif.

PSEUDOPOLYMORPHINA VARIATA (Jones, Parker, and H. B. Brady)

Plate 26, figures 5, 6

Polymorphina variata JONES, PARKER, and H. B. BRADY, Foram. Crag, pt. 1, 1866, pl. 1, figs. 67, 68.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 237, pl. 40, fig. 24.—JONES, Foram. Crag, pt. 2, 1895, pl. 5, fig. 27; pt. 3, 1896, p. 272.

Test suboblong to oblong, compressed, the greatest breadth above the middle; chambers rounded, compressed, arranged in an almost biserial series from the beginning; sutures depressed, but not very

distinct; wall studded with irregular, angular, low elevations imparting a mottled appearance to the exterior, sometimes marked with strong angular elevations unequally distributed; aperture radiate.

Maximum length 1.60 mm.; breadth 1.25 mm.; thickness 0.30 mm.

The present very interesting species is described from the Crag of Sutton for the first time by Jones, Parker, and H. B. Brady, who characterize the species as having the surface with irregular and angular depressions. We have examined material from the same locality and found several specimens showing the same characters as *Pseudopolymorphina variata* excepting surface ornamentation. Our specimens are ornamented with irregular elevations instead of depressions. We have well preserved specimens from the Miocene of Pontlevoy in France, which are marked by graphically distributed elevations imparting to the surface an appearance of depressions at lower magnification.

Terquem figured two different specimens obtained from the Pliocene of the Isle of Rhodes under the name *Polymorphina fischeri*. One has a smooth surface, while the other has a many-chambered elongate test, the wall of which, according to his description, is rugose or arenaceous. If his specimen really belongs to the Polymorphinidae, we may suppose it may be rugose and not arenaceous. His smooth specimen is separated as a variety of the present species.

Distribution.—The species seems to be limited to the late Tertiary in Europe. Brady, Parker, and Jones's specimens are from the Crag of Sutton, where it is rather common. We have specimens from the type locality at Sutton and from the Miocene of Pontlevoy, France. Terquem's rough specimen from the Pliocene of the Isle of Rhodes is probably to be placed under this species.

PSEUDOPOLYMORPHINA VARIATA (Jones, Parker, and H. B. Brady) var. FISCHERI (Terquem)

Plate 10, figures 6, 7; Plate 26, figures 7, 8

Polymorphina fischeri TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 41, pl. 3 (8), figs. 37, 39.

Guttulina racemosa TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 46, pl. 4 (9), figs. 20–22 (not figs. 23, 24).

Polymorphina compressa JONES, Foram. Crag, pt. 3, 1896, p. 258, pl. 1, figs. 54, 65, 77–80; and (distorted) pl. 5, figs. 26, 28.

Polymorphina dilatata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 11.—FORNASINI, Riv. Ital. Pal., vol. 8, 1902, p. 2, pl. 1, fig. 5.

Polymorphina lecointreae ALLIX, Feuille des Jeunes Naturalistres, vol. 43, 1913, p. 34, fig. 5 (in text).

Polymorphina consecta D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 10.—FORNASINI, Riv. Ital. Pal., vol. 8, 1902, p. 2, pl. 1, fig. 4.

Variety differing from the typical form in having a smooth surface. Maximum length 2 mm.; breadth 1.30 mm.; thickness 0.50 mm.

As remarked in the case of the typical form, Terquem's species, *Polymorphina fischeri*, contains both smooth and ornamented forms. The form having a smooth surface is described and figured before the ornamented form, which coincides with *Pseudopolymorphina variata*. Therefore Terquem's specific name *fischeri* is used as a varietal name for the smooth variety of *P. variata*.

Jones included a smooth variety from the Crag in *Polymorphina compressa*, but their difference is very conspicuous. The present variety has compressed but more rounded chambers instead of elongated chambers as in *Polymorphina compressa*.

Polymorphina dilatata listed by d'Orbigny and figured by Fornasini, considered from the figure, is very close to the present variety. *Polymorphina lecointreae* Allix, as reported from the Miocene of Touraine, has rather rounded chambers separated by more or less depressed sutures, and may be included in the range of variation of the present variety.

Some figures of *Guttulina racemosa* Terquem described in the same paper as the present variety appear to be very similar to a young stage of the present variety. They are probably young specimens. Two specimens somewhat resembling Terquem's *Guttulina racemosa* are figured.

Distribution.—The present variety generally occurs associated with the typical form, and it seems to be limited to the late Tertiary of Europe. The localities of our identified specimens are as follows:

Pliocene.—Crag, of Suffolk, England. Isle of Rhodes.

Upper Miocene.—Pontlevoy, France; near Bordeaux, France.

PSEUDOPOLYMORPHINA OVALIS Cushman and Ozawa, new name

Plate 27, figures 1 *a–c;* Plate 29, figures 6 *a–c*

Polymorphina ovata D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 233, pl. 13, figs. 1–3 (not of 1826).—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 564, pl. 72, figs. 7, 8.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 151, pl. 40, figs. 11, 12.

Test fusiform, more or less compressed, elliptical in end view; chambers inflated, much embracing, arranged in a nearly biserial series, each succeeding chamber not much removed from the base; sutures but little depressed, fairly distinct; wall smooth; aperture radiate.

Length 0.85 mm.; breadth 0.65 mm.

D'Orbigny's *Polymorphina ovata*, described in the Vienna monograph, is evidently different from *Polymorphina* (*Globulina*) *ovata*, named in 1826, but was neither figured nor described by d'Orbigny. *Polymorphina ovata*, therefore, as a specific name can not be used, and a new name *ovalis* is proposed.

Pseudopolymorphina ovalis has a more or less compact test, consisting of rather inflated chambers arranged in an almost biserial series, and it is more or less related to *Pyrulina*, but the compressed fusiform test having the chambers arranged in a biserial series shows a closer relationship of the present species to *Pseudopolymorphina*, where we have placed it.

Distribution.—*Pseudopolymorphina ovalis* is rather rare in the *Amphistegina* marl of Grunes Kreuz, Nussdorf, in Vienna. It is rarely found in the Recent state, and the specimens noted below are not entirely typical. We have specimens of the present species from the following localities:

Recent.—*Albatross* Station D3407, in 885 fathoms off the Galapagos Islands, and D4807 in 44 fathoms off Japan. Single specimens from each station are larger than the typical form and may not be the same.

Pliocene.—Belgium, Crag noir, Antwerp.

Miocene.—Austria, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna. Hungary, Kostej, Banat. France, Burdigalien inferieur, Moulin de l'Eglise, Saucats.

PSEUDOPOLYMORPHINA OBSCURA (Roemer)

Plate 27, figures 2 *a–b*

Polymorphina obscura Roemer, Neues Jahrb. f. Min., etc., 1838, p. 385, pl. 3, fig. 23.—Reuss, Sitz. Akad. Wiss. Wien, vol. 50, abt. 1, 1864, p. 471, pl. 3, figs. 8–10.

Polymorphina teretiuscula Roemer, Neues Jahrb. f. Min., etc., 1838, p. 385, pl. 3, fig. 24.

Polymorphina campanulata Roemer, Neues Jahrb. f. Min., etc., 1838, p. 385, pl. 3, fig. 22.

Polymorphina subdepressa Roemer, Neues Jahrb. f. Min., etc., 1838, p. 385, pl. 3, fig. 28.

Test elongate, compressed, sides nearly parallel, slightly broader near the apertural end, initial end rounded; chambers not elongated, slightly embracing, arranged at first in a quinqueloculine series, and later biserial; sutures but little depressed, distinct; wall thick, smooth; aperture radiate.

Length of figured specimen 3.30 mm.; breadth 1.25 mm.; thickness 0.65 mm.

We have the same opinion as Reuss, who in the paper on the fauna of the German upper Oligocene, published in 1864, put together under *P. obscura: Polymorphina obscura*, *P. teretiuscula*, and *P. campanulata* figured by Roemer.

Polymorphina subdepressa v. Münster, described for the first time by Roemer in the same paper as the above three, has a much rounded initial end, few chambers, and short test, and may be considered as the megalospheric form of the present species. The early chambers are not biserial, and for this reason we have placed the species in *Pseudopolymorphina*.

Distribution.—We have a good series of the present species from the upper Oligocene of Ahnatal, near Cassel, Germany. There is a single specimen in the collection from the Oligocene of Lattdorf, Germany.

PSEUDOPOLYMORPHINA CURTA Cushman and Ozawa, new species

Plate 27, figures 3 *a*, *b*

Pseudopolymorphina species CUSHMAN and OZAWA, Jap. Journ. Geol. and Geogr., vol. 6, 1929, p. 71, pl. 15, fig. 7.

Test oval, compressed, rounded at both ends, margin even; chambers few, as long as wide, more or less compressed, slightly embracing, arranged in an almost biserial series; sutures but little depressed, often obscured; wall thin, smooth; aperture radiate.

Length of holotype 0.55 mm.; breadth 0.40 mm.; thickness 0.27 mm.

Holotype.—(Cushman Coll. No. 11731.) From 32 fathoms, one-half mile northwest of Eagle Island, Casco Bay, Me.

A characteristic of the species is the oval test composed of a few more or less compressed rounded chambers. *Pseudopolymorphina* species recorded by us from the upper Pliocene of Sawane, Japan, is very similar to the present species.

Distribution.—In addition to the above localities, we have specimens from Hudson Bay, Richmond Gulf (about 3 miles from entrance, in 15–20 fathoms).

PSEUDOPOLYMORPHINA SPATULATA (Terquem)

Plate 27, figures 4, 5

Polymorphina spatulata TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 142, pl. 14 (22), figs. 32 *a*, *b*.

Polymorphina truncata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 3.—FORNASINI, Boll. Soc. Geol. Ital., vol. 19, 1900, p. 152, fig. 6 (in text).

Test slightly compressed, elongated, periphery broadly rounded; chambers inflated, slightly overlapping, arranged at first in a nearly quinqueloculine or triloculine series especially in the microspheric form, abruptly becoming biserial; sutures but little depressed, distinct; wall smooth; aperture radiate.

Maximum length 2.30 mm.; breadth 0.55 mm.; thickness 0.30 mm.

As is noted in the remark given with *Pseudopolymorphina decora*, it is difficult to distinguish *Pseudopolymorphina spatulata* from *Pseudopolymorphina decora* because of transitional forms. Especially the megalospheric form of the present species, having an almost biserial test, shows a great resemblance to *Pseudopolymorphina decora*.

Polymorphina truncata d'Orbigny, figured by Fornasini, having alternating rounded chambers, is not different from the present species, although its apertural view is almost circular.

Distribution.—Our specimens are mostly from the Miocene of France, where the species is common and well developed. We have specimens from the following localities:

Miocene.—France, Aquitanian superieur, St. Avit, near Mont de Marson, near Bordeaux; Burdigalien superieur, Merignac (Gironde); Burdigalien inferieur, Le Coquillat, Leognan; Moulin de l'Eglise, Saucats.

Oligocene.—Upper, Germany, Ahnatal, near Cassel.

PSEUDOPOLYMORPHINA DOLLFUSSI Cushman and Ozawa, new species

Plate 27, figures 6, 7

Test cylindrical, but little compressed, rounded at the base, obtuse at the apertural end; chambers elongated, not much embracing, arranged at first in a triserial series, becoming biserial later, each succeeding chamber removed much farther from the base; sutures very little depressed, not very distinct; wall rather thin, smooth; aperture large, radiate.

Length 0.95–1.40 mm.; breadth 0.28–0.35 mm.; thickness 0.18–0.22 mm.

Holotype.—(Cushman Coll. No. 11739.) From the Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. Paratype in collection of Geological Institute, Imperial University of Tokyo, Tokyo, Japan.

The present species has a tendency to become more or less uniserial in the later stages, but the sutures are invariably oblique and the chambers alternating.

This species is named for Dr. G. Dollfuss, of Paris, formerly President of the Société Géologique of France, who furnished excellent material from the Miocene of France for our studies.

Distribution.—This species occurs in the Miocene of France. We have specimens from the following localities:

Miocene.—Aquitanian superieur, La Brede, Larriey, near Bordeaux; Burdigalien superieur, Merignac (Gironde); Burdigalien inferieur, La Coquillat, Leognan.

PSEUDOPOLYMORPHINA DOLLFUSSI Cushman and Ozawa var. TENUISTRIATA Cushman and Ozawa, new variety

Plate 27, figures 8 *a*, *b*

Variety differing from the typical in the ornamentation of the test, which consists of very fine longitudinal striations.

Length 0.80–1.10 mm.; breadth 0.18–0.25 mm.; thickness 0.15–0.22 mm.

Holotype of variety.—(Cushman Coll. No. 11743.) From the Miocene of St. Paul de Dax, near Bordeaux, France. Paratypes in the collection of the University of Tokyo.

PSEUDOPOLYMORPHINA JONESI Cushman and Ozawa, new species

Plate 28, figures 1 *a–c*

Polymorphina nodosaria JONES, Foram. Crag, pt. 3, 1896, p. 262, pl. 1, figs. 55–58 (*Dimorphina*).

Polymorphina thouini JONES (not d'Orbigny), Foram. Crag, pt. 3, 1896, p. 261, pl. 1, fig. 59.

Test cylindrical, elongated, rounded at the base; chambers as long as wide, circular in transverse section, arranged at the beginning in a triserial series, later becoming uniserial; sutures but little depressed, distinct; wall smooth; aperture radiate.

Length of holotype 1.60 mm.; breadth 0.35 mm.

Holotype.—(Cushman Coll. No. 11745.) From Miocene, Burdigalien of St. Paul de Dax, near Bordeaux, France.

Pseudopolymorphina jonesi is different from Reuss's *Polymorphina nodosaria* and *P. subnodosa* in having the chambers not inflated and the sutures not depressed. Jones's *Polymorphina nodosaria* and *P. thouini*, figured from the Coralline Crag of Sutton, are the same as the present species. It may be noticed here that d'Orbigny's *Dimorphina nodosaria*, described from the Vienna Basin, is a *Marginulina*.

Distribution.—Jones's specimens were from the Pliocene Crag of Sutton, England. We have specimens also from the Miocene of St. Paul de Dax, near Bordeaux, France.

PSEUDOPOLYMORPHINA SUBCYLINDRICA (Hantken)

Plate 28, figures 2 *a–c*

Polymorphina subcylindrica HANTKEN, A Magy. Kir. földt. int. evkönyve, vol. 4, 1875 (1876), p. 51, pl. 14, fig. 14; Mitth. a. d. Jahrb. k. ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 60, same pl. and fig. (misprinted *subcyindrica* in explanation of plate).

Cristellaria pleurostomelloides KARRER, Sitz. k. Akad. Wiss. Wien, vol. 58 (1), 1868, p. 171, pl. 4, fig. 5.

Psecadium oblongum FRANZENAU, Glasnik. kr. nar. drutztva God., vol. 6, 1894, p. 275, pl. 4, fig. 52.

Test elongated, more or less irregularly cylindrical, rounded at the base; chambers longer than wide, arranged at the start in a nearly triserial series, later becoming more or less uniserial, but little embracing; sutures depressed, distinct; wall smooth, thick; aperture radiate.

Length of figured specimen 1.20 mm.; breadth 0.40 mm.; thickness 0.35 mm.

Hantken's figure of the present species shows a nearly triserial arrangement of the earlier three chambers, to which are added two uniserial chambers. The chambers are not much elongated and are separated by depressed sutures. Our figured specimen from the Vienna Basin resembles Karrer's *Cristellaria pleurostomelloides* from Kostej, and has slightly longer chambers than Hantken's species, although there is no important difference between them.

Psecadium oblongum Franzenau, judging from his figure, is very close to Hantken's species and is provisionally placed under the present species.

Distribution.—Hantken reported the present species from the Eocene of Ofen (Kleinschwabenberg), where he found only one specimen. Karrer noted its occurrence as very rare. We have a single specimen from the Miocene (Tortonian) of the Vienna Basin.

PSEUDOPOLYMORPHINA DIGITATA (d'Orbigny)

Plate 28, figures 3 *a*, *b*

Polymorphina digitata d'Orbigny, Guerin-Menevilles Cuvier, Iconographie, Mollusques, 1829–43, p. 9, pl. 3, fig. 3.

Polymorphina nodosaria Franke, Danmarks Geol. Unders. II, Raekke, No. 46, 1927, p. 35, pl. 3, fig. 18.

Test elongate, cylindrical, rounded at both ends; chambers short, nearly as long as broad, slightly embracing, arranged in an entirely biserial series; sutures but little depressed, distinct; wall smooth; aperture radiate.

Length of figured specimen 1.95 mm.; breadth 0.55 mm.; thickness 0.50 mm.

The present species was only figured and not described by d'Orbigny under the name *Polymorphina digitata.*

Moreover, neither the locality nor geological formation of the species was mentioned, and accordingly there is great difficulty in determining exactly the species. We have several specimens from the Upper Cretaceous of Maastricht, which in every feature resemble d'Orbigny's figure of *Polymorphina digitata*, and those specimens are provisionally determined as the same as d'Orbigny's species, and one of them is figured.

Pseudopolymorphina digitata of our identifications resembles in some respects *P. spatulata* from the Miocene of Europe, but the latter is more compressed, and its chambers are longer.

Distribution.—We have specimens of the species from the Upper Cretaceous of Maastricht only.

PSEUDOPOLYMORPHINA LEOPOLITANA (Reuss)

Plate 28, figures 4 *a–c*

Polymorphina leopolitana Reuss, Haidinger's Nat. Abhandl., vol. 4, 1851, p. 28, pl. 4, fig. 11.

Polymorphina rudis Reuss, Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 319, pl. 3, figs. 5–8.

Test elongated, slightly compressed, rounded at the base; chambers inflated, but little embracing, arranged in a nearly biserial series from the beginning, often tending to become uniserial in later development; sutures depressed, distinct; wall smooth; aperture radiate.

Length 1.10–1.50 mm.; breadth 0.45–0.65 mm.; thickness 0.45–0.65 mm.

Pseudopolymorphina leopolitana is evidently related to *P. soldanii*, and they have some characters in common, such as inflated chambers and slightly compressed test.

The present species however, has a much more elongated test, which lacks a triserial arrangement of chambers in its early stages and becomes more or less uniserial in its later stages.

Reuss separated *Polymorphina rudis* from *Pseudopolymorphina leopolitana* by its much larger test and its more nearly uniserial arrangement of chambers. As he noted, *Polymorphina rudis* is very variable, and we can hardly find two specimens quite alike, therefore it is better to unite Reuss's two species cited above.

Distribution.—Reuss's *Polymorphina leopolitana* is recorded from the *mucronata* bed of Lemberg (Cretaceous) and his *Polymorphina rudis* from Cretaceous tuff of Maastricht, in material from which we found several specimens.

The figured specimen is from the chalk marl, Saxon Cement Works, Cambridge, England.

PSEUDOPOLYMORPHINA MENDEZENSIS (White)

Plate 28, figures 7–9

Polymorphina mendezensis WHITE, Journ. Pal., vol. 2, 1928, p. 213, pl. 29, fig. 14.

Test compressed, broadly oval to oblong, rounded at the base; chambers rounded, compressed, arranged at first in a nearly triserial series, becoming biserial, each succeeding chamber removed farther from the base; sutures but little depressed, usually distinct; wall thick, smooth; aperture radiate.

Length 0.60–0.75 mm.; breadth 0.35–0.45 mm.; thickness 0.20–0.30 mm.

The present species is very variable in its general outline, some broadly rounded at the end consisting of much compressed chambers, the others much narrower at the initial end as each succeeding more or less inflated chamber is removed farther from the base.

In spite of the variable shape of the test, the arrangement of chambers is rather definite, and is always nearly triserial at the start, becoming biserial later. A quinqueloculine arrangement of chambers is lacking in this species.

Distribution.—Pseudopolymorphina mendezensis is very common in the Upper Cretaceous deposits in North America. We have no European specimen representing the present species.

White recorded it from the base of the Mendez to a point a little above the base of the Velasco. It occurs also in our material from the Navarro formation of Texas in various cores. At the clay pit 3

miles South of Corsicana, Tex., it is very common. We have specimens from the Chipley well in Florida at 2,520 feet.

PSEUDOPOLYMORPHINA SUBNODOSA (Reuss)

Plate 29, figure 2

Polymorphina subnodosa REUSS, Sitz. Akad. Wiss. Wien, vol. 42, 1860, p. 362, pl. 2, fig. 15.

Polymorphina nodosaria REUSS, Sitz. Akad. Wiss. Wien, vol. 48, pt. 1, 1863, p. 58, pl. 7, fig. 85.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 233, pl. 40, figs. 18 *a*, *b*.

Test almost cylindrical, more or less tapering toward the base; chambers inflated, not much embracing, alternating, arranged in a nearly biserial series, becoming uniserial; sutures oblique, depressed; wall smooth; aperture radiate.

Brady, Parker, and Jones put Reuss's *Polymorphina subnodosa* and *P. nodosaria* together, reserving the latter name because the former does not represent as good a type as that later described under the name which they have adopted. *Polymorphina subnodosa* was described and figured as well as *P. nodosaria*, and the former has the priority; therefore we keep the specific name "*subnodosa*" according to the rule of priority.

We have not found any specimen resembling the present species. The above description is written in accordance with Reuss's figure of the species.

Distribution.—The present species is apparently limited to the Tertiary of Europe. Reuss's records are the middle Tertiary of central Germany and the Crag of Antwerp.

PSEUDOPOLYMORPHINA INCERTA (Egger)

Plate 29, figures 3–5

Polymorphina incerta EGGER, Neues Jahrb. fur Min., Jahrg. 1857, p. 286, pl. 13, figs. 19–21.

Polymorphina depressa D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 26.

Globulina depressa TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 131, pl. 13 (21), figs. 28–30.

Polymorphina (*Globulina*) *depressa* FORNASINI, Riv. Ital. Pal., vol. 8, 1902, p. 2, pl. 1, fig. 8.

Polymorphina depauperata REUSS, Sitz. Akad. Wiss. Wien, vol. 55, pt. 1, 1867, p. 89, pl. 3, fig. 9.

Polymorphina amygdaloides REUSS var. *lepida* FORNASINI, Mem. Istit. Accad. Sci. Bologna, ser. 5, vol. 9, 1900–1902 (1902), p. 71, fig. 24 (in text).

Polymorphina subdilatata EGGER, Neues Jahrb. für Min., Jahrg., 1857, p. 286, pl. 13, figs. 30–33.

Polymorphina media EGGER, Neues Jahrb. für Min., Jahrg., 1857, p. 287, pl. 13, figs. 28, 29.

Polymorphina solidula TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 40, pl. 3 (8), figs. 31*a*–33.

Test almost equally compressed on both sides, oval, margin rounded; chambers not numerous, usually five or six, compressed, usually almost as broad as long, arranged in a nearly biserial series; sutures not depressed; wall smooth; aperture radiate.

Length, 0.55–0.75 mm.; breadth, 0.45–0.60 mm.; thickness, 0.18–0.25 mm.

Several different names were given by various authors to the different phases of growth of the present species. *Globulina depressa*, listed by d'Orbigny from the environs of Beauvais in 1826 and figured much later by both Terquem and Fornasini, having four chambers, evidently represents a young stage of the present species. The name, however, can not be used, as the 1826 species was not described or figured until much later.

Polymorphina solidula Terquem is a form having the last chamber added in a slightly abnormal manner. We have such specimens among our collections of *Pseudopolymorphina incerta.*

Polymorphina depauperata Reuss is undoubtedly the same as *Globulina depressa* in every respect.

Polymorphina incerta Egger, having the priority among several specific names proposed for the present species, is an adult and more common form.

Polymorphina amygdaloides var. *lepida* Fornasini, with slightly acute initial end, and *Polymorphina subdilatata* Egger are forms of the present species having a more or less elongate test.

Polymorphina foveolata was separated by Reuss from *Polymorphina depauperata* because of its thicker and more or less irregularly oval test and sparsely distributed surface depressions, but such differences appear to us not as important as the other more essential characters which show no real differences between the above two species.

Polymorphina media Egger has an elongate test and is in some respects unlike the present species, but we think it is better to place it as within the range of variation of *Pseudopolymorphina incerta.*

Distribution.—One of the most common species distributed widely in the European younger Tertiary deposits. We have the species from the following localities:

Recent.—Italy, shore sand of Rimini on the Adriatic.

Miocene.—France, Helvetien, Pontlevoy; Aquitanien superieur, St. Avit, near Mont de Marsen; La Brede, Larriey; Burdigalien superieur, Merignac (Gironde); Burdigalien inferieur, Dax; Moulin de l'Eglise, Saucats; Le Coquillat, Leognan. Hungary, Tortonian, Varpolata.

Eocene.—France, Lutetien, *Orbitolites* bed, Grignon. England, Bracklesham bed XVII, White Cliff Bay, Isle of Wight.

Genus PALEOPOLYMORPHINA Cushman and Ozawa, new genus

Test with the early chambers spiral, later ones becoming biserial.

Genotype.—*P. pleurostomelloides* (Franke).

PALEOPOLYMORPHINA PLEUROSTOMELLOIDES (Franke)

Plate 28, figures 5 *a*, *b*

Polymorphina pleurostomelloides FRANKE, Abhandl. d. preuss. geol. Landesanstalt, vol. 3, 1928, p. 121, pl. 11, fig. 11.

Test small, more or less cylindrical, tapering toward the initial end; chambers inflated, oval, but little embracing, alternating, arranged in an entirely biserial series, each succeeding chamber much farther removed from the base; sutures oblique, much depressed, distinct; wall smooth; aperture radiate.

The present species quite recently has been described by Franke from the lower Cenomanian marl of Tecklenburg, a locality from which we obtained foraminiferal material from the original author and found three specimens. They are very similar to *Pleurostomella*, excepting for the radiate aperture. Its development is evidently a biserial one from a spiral ancestry, and as such we have erected a new genus for it and the following species.

Distribution.—Germany, lower Cenomanian, Tecklenburg, Westphalia, near the brickyard of Hollenberg, where it is not rare.

PALEOPOLYMORPHINA GAULTINA (Berthelin)

Plate 28, figures 6 *a*, *b*

Polymorphina gaultina BERTHELIN, Mém. Soc. Géol. France, sér. 3, vol. 1, 1880, p. 58, pl. 4, figs. 19 *a–c.*

Test small, more or less compressed, fusiform, acute at both ends; chambers few, the last two much larger than the earlier ones, embracing, arranged in a biserial series, each succeeding chamber removed from the base; sutures but little depressed, distinct; wall smooth; aperture radiate.

Paleopolymorphina gaultina is one of the smallest species among the Polymorphinidae. The test is generally composed of five chambers, of which the last two are much enlarged. It is a well-defined species and can be easily distinguished from any other.

Distribution.—Berthelin described it from the Lower Cretaceous (Albian) of France. We have several specimens from the Gault of Folkestone, England.

Genus POLYMORPHINA d'Orbigny, 1826

POLYMORPHINA BURDIGALENSIS d'Orbigny

Plate 29, figures 7 *a–c*

Polymorphina burdigalensis D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 2; model No. 29.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 224, pl. 39, figs. 9 *a*, *b*.—CUSHMAN and OZAWA, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 1, 1928, p. 16, pl. 2, fig. 10.—OZAWA, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 2, 1929, p. 35, pl. 6, figs. 1–3.

Polymorphina burdigalensis D'ORBIGNY var. *lequilensis* FORNASINI, Mem. Istit. Bologna Acad. Sci., ser. 5, vol. 9 (1900–1902), p. 73, fig. 26.

Test fusiform to oblong, more or less flattened on one side, unsymmetrically convex on the other; chambers elongate, more embracing on the flattened side, arranged in an almost biserial series from the start; sutures scarcely depressed, distinct; wall smooth, translucent; aperture radiate.

Length of figured specimen 0.75 mm.; breadth 0.40 mm.; thickness 0.25 mm.

Ozawa found that d'Orbigny's original specimen deposited in the paleontological department, Museum of Natural History, Jardin des Plantes in Paris, is lost, and the species has been neither figured nor described by d'Orbigny; therefore the only reference having any authority is a plaster model. Brady, Parker, and Jones figured a model of *Polymorphina burdigalensis* in their monograph, but as far as the figures are concerned their model is different from that in the Cushman Laboratory, because those figures are the reverse of that form shown by this model; but all models of *Polymorphina burdigalensis*, including that in the British Museum of Natural History, which was examined, are just the same as this. Apparently this reversal came in the drawing of the figures, a similar reversal being shown in other species in Brady, Parker, and Jones' monograph. According to the Tableaux Méthodique, d'Orbigny's specimen was obtained from the Miocene in the environs of Bordeaux. We have examined much material from the same locality, as well as from Dax, and only one specimen somewhat resembling the model was found. The specimen figured here is just the same as *Polymorphina burdigalensis*, at least in the degree of embracing of the elongate chambers and an unequal compression on each side of the test, although the arrangement of chambers is not as regular as shown by the model, which should be considered to be somewhat coventionalized.

Fornasini's *Polymorphina burdigalensis* var. *lequilensis*, obtained from Lequile, is almost the same as ours.

Distribution.—The locality of our figured specimen is Miocene (Burdigalien inferieur), Moulin de l'Eglise, Saucats, (Gironde), France.

POLYMORPHINA FORNASINII Cushman and Ozawa, new species

Plate 29, figures 8 *a*, *b*

Test compressed, oblong, greatest breadth in the upper half tapering toward the acute base, periphery rounded; chambers elongated, arranged at first in a more or less sigmoid series becoming regularly biserial; sutures slightly depressed, distinct; wall smooth, thin, transparent; aperture radiate.

Length of holotype 1.25 mm.; breadth 0.60 mm.; thickness 0.30 mm.

Holotype.—(Cushman Coll. No. 9,867.) Recent, off Tripoli.

The early chambers of the species are sigmoidally arranged, but the later ones are regularly biserial and alternating, sometimes becoming very irregular and spreading.

The species is named for Prof. C. Fornasini of Bologna, Italy.

POLYMORPHINA INCAVATA Stache

Plate 29, figures 9 *a*, *b*

Polymorphina incavata STACHE, *Novara* Exped., Geol. Theil 1, 1864, p. 260, pl. 24, figs. 7 *a*, *b*.

Polymorphina dispar STACHE, *Novara* Exped., Geol. Theil 1, 1864, p. 261, pl. 24, figs. 8 *a*, *b*.

Test more or less compressed, elongated, rounded at the base; chambers twice as long as wide, more or less inflated, not much embracing, arranged in a biserial series; sutures slightly depressed, distinct; wall smooth; aperture radiate.

We have no specimen which we can identify with the present species, and the above description is given in accord with the original figures. Stache's *P. dispar* is very similar to the present species. It may be a young specimen. It seems to be known only from the Tertiary, Upper Eocene, at Whaingaroa Port, New Zealand.

POLYMORPHINA SUBRHOMBICA Reuss

Plate 30, figures 1–3

Polymorphina subrhombica REUSS, Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 339, pl. 7, fig. 3.

Test compressed, rhombic (young) to subrhomboidal (adult), symmetrical, margin angular; chambers rather broad, not much embracing, alternating; wall smooth, thick; sutures not depressed, but distinct; aperture radiate.

Maximum length 2.60 mm.; breadth 1.30 mm.; thickness 0.50 mm.

The present species has fairly large dimensions and even a few chambered specimen attains 1 millimeter in length. It has but a slight resemblance to *Polymorphina complanata*, with which it has been generally considered to be identical. The narrow elliptical end view is enough to separate the present species from any other of the

known species of *Polymorphina* having the chambers arranged in an entirely biserial manner.

Distribution.—Reuss first described *Polymorphina subrhombica* from the Upper Cretaceous (?) (Eocene (?)) of New Jersey, where it is rather common in the Eocene formation, and from which we have several specimens. The formation formerly supposed to be Cretaceous in New Jersey is probably Eocene.

POLYMORPHINA ACULEATA d'Orbigny

Plate 30, figure 4

Polymorphina aculeata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 265, No. 5.—FORNASINI, Riv. Ital. Pal., vol. 8, 1902, p. 1, pl. 1, fig. 1.

Test compressed, elongate, margins almost parallel, acute at both ends, initial end with a spine; chambers compressed, elongate, alternating; sutures but little depressed, distinct; wall ornamented with fine costae, interrupted at the sutures; aperture produced, radiate.

Polymorphina aculeata, listed by d'Orbigny but not figured or described until 1902 by Fornasini, is a well-characterized species reported from the environs of Paris. We have examined material from the Paris Basin, but we could not find any specimen like this. The above description is based on Fornasini's figure.

Distribution.—Known only from the Eocene of the Paris Basin.

POLYMORPHINA LONGISTRIATA Cushman and Ozawa, new species

Plate 30, figure 5

Polymorphina complanata (D'ORBIGNY) var. *striata* BURROWS and HOLLAND, Proc. Geol. Assoc., vol. 15, 1897, p. 46, pl. 2, fig. 15.

Test elongate, rhomboidal, compressed, almost symmetrical; chambers compressed, alternating, arranged in an entirely biserial series; sutures slightly depressed, distinct; wall ornamented by longitudinal costae interrupted at the sutures; aperture radiate.

We have examined material which we collected from the Thanet beds of Pegwell Bay, but we did not find any specimen like *Polymorphina complanata* var. *striata* described by Burrows and Holland. This seems to be quite distinct from any described species. It is evidently related to *Polymorphina complanata* d'Orbigny in its much specialized biserial arrangement of chambers, but it is not only ornamented but the test is also much elongated and its chambers are much broader than those of *Polymorphina complanata*.

A new specific name "*longistriata*" is proposed.

Its nearest ally seems to be *Polymorphina advena* Cushman, from which it is separated by its more elongate, angular test, and coarser ornamentation.

Distribution.—The only known record is from the Thanet beds of Pegwell Bay in England.

POLYMORPHINA PARALLELA Millett

Plate 30, figures 6 *a*, *b*

Polymorphina regularis var. *parallela* MILLETT, Trans. Roy. Geol. Soc. Cornwall, 1894, pp. 4, 7 (list), pl., figs. 5, 6 *a*, *b*.

Test compressed, oblong, margins nearly parallel; chambers elongate, compressed, alternating; sutures not depressed; wall smooth, translucent; aperture radiate.

The present species is recorded by Millett under the name of *Polymorphina regularis* var. *parallela*. His description runs as follows:

"This variety has the characters both of *P. regularis* and *P. frondiformis*. It differs from the former in having the lateral faces parallel, and from the latter in the fact that the sutures do but rarely reach the central line of the test, leaving a clear space from the oral to the aboral ends."

It is quite distinct from *Sigmomorpha regularis* in its arrangement of sutures. It resembles in some features *Polymorphina frondea*, but the latter has the periphery with raised margins.

Distribution.—Millett's specimens are from the Pliocene of St. Erth, England.

POLYMORPHINA ALLENI Cushman and Ozawa, new species

Plate 30, figures 7 *a*, *b*

Polymorphina complanata HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1909, p. 432, pl. 17, figs. 3–5.

Test broadly oval, much compressed, symmetrical; chambers curved, elongate, cylindrical, alternating, each succeeding chamber slightly removed from the base; sutures depressed, distinct, uniformly curved; wall rather thin, translucent, smooth; aperture radiate.

Length of holotype 0.70 mm.; breadth 0.37 mm.; thickness 0.12 mm.

Holotype.—(Cushman Coll. No. 11777.) From Eocene, Bracklesham bed XVIII, White Cliff Bay, Isle of Wight, England.

Heron-Allen and Earland described and figured from Selsey a pretty biserial specimen of *Polymorphina* under the name of *P. complanata* d'Orbigny. We have a specimen from the Bracklesham bed XVIII, White Cliff Bay of Isle of Wight, which in every respect coincides with Heron-Allen and Earland's species. This is quite distinct from *Polymorphina complanata* from the Vienna Basin in the uniform, strongly curved, cylindrical chambers, all of which come down much farther toward the base than in *P. complanata*.

To the present species a new specific name *alleni* is given for Edward Heron-Allen.

POLYMORPHINA CUSHMANI Plummer

Plate 30, figures 8 *a*, *b*

Polymorphina cushmani PLUMMER, Bull. 2644, Univ. Texas, 1927, p. 125, pl. 6, fig. 9; pl. 15, figs. 1 *a–c*.

Test compressed, oblong, broadest at the upper half, rhomboidal in end view, margins angular but not carinate; chambers elongate, alternating in an entirely biserial series; sutures not depressed, straight, often thickened and obscured; wall thick, ornamented in the middle part of the broad faces with raised beads arranged longitudinally from the aperture to the initial end or not more than four, strong, broken costae developing independently of the sutures; aperture radiate.

Maximum length 2.60 mm.; breadth 1.30 mm.; thickness 0.60 mm.

Polymorphina cushmani is one of the best defined species of the genus. Its straight sutures and peculiar ornamentation are the special features that will separate it from the species related to it.

Distribution.—This species seems to be limited to the lower Eocene, Midway, of the Texas region. Mrs. Plummer describes it from the base of a high bluff on west side of Colorado River between the Travis-Bastrop County line and the mouth of Dry Creek (Bastrop quadrangle), Tex., and 5¼ miles due south and very slightly west of Littig, where the 440-foot contour cuts a northeast-southwest road (Bastrop quadrangle), Texas. The specimen here figured is from the station near Littig, kindly sent us by Mrs. Plummer. We also have typical specimens from the Midway of Texas in our collection from other Texas localities.

Mrs. Plummer's notes on the occurrence of this species are given here:

> In the Midway formation *P. cushmani* is most frequent in the glauconitic sands and clays in the upper part of the transition zone, which in the belt of outcrop northeast of the Mexia area is marked by phosphatic nodules and southwest of this same area by the abundance of *Venericardia bulla*. In some outcropping clays it is of sufficient abundance to be detected with the aid of a hand lens. Because no other formation in the Texas geologic section has yielded a compressed Polymorphine test bearing strong longitudinal markings, *P. cushmani* becomes very useful as a Midway signpost. The underlying Navarro formation carries very rarely a somewhat similar large species that is much smoother and possesses fewer chambers in its fullest development.

POLYMORPHINA COMPLANATA d'Orbigny

Plate 30, figures 9 *a*, *b*

Polymorphina complanata D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 234, pl. 13, figs. 25–30.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 230, pl. 40, figs. 14 *a*, *b*; woodcuts *f–j*.

Test rhombic in outline, much compressed, greatest breadth above the middle, acute toward the initial end; chambers elongate, slender,

compressed, arranged in a regular biserial series, alternating almost equally upon the two sides, slightly embracing, each succeeding chamber removed farther from the base; sutures slightly depressed, distinct; wall smooth; aperture radiate.

Maximum length 1.25 mm.; breadth 0.95 mm.; thickness 0.15 mm.

Polymorphina complanata is highly specialized and can be easily distinguished from any other described species by its much compressed and rhombic test. The arrangement of the chambers is also very regular and entirely biserial, and a *Guttulina*-like stage is skipped in this species.

Many forms are recorded as *Polymorphina complanata* from various parts of the world, but are all different from the species described by d'Orbigny from the Vienna Basin.

Distribution.—The present species is only known from the Tortonian, *Amphistegina* marl, at Grunes Kreuz, Nussdorf, near Vienna, where it is fairly common. Ozawa collected more than 50 specimens from this locality. D'Orbigny reported its occurrence in the Tortonian clay of Baden, but there is no original or paratype specimen of the present species from Baden, and Ozawa could not find any specimen like the present one in all the material he collected and prepared from that locality.

POLYMORPHINA ADVENA Cushman

Plate 30, figures 10 *a*, *b*

Polymorphina advena CUSHMAN, U. S. Geol. Survey Prof. Paper 129–F, 1922, p. 132, pl. 31, fig. 4; Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 41, pl. 7, fig. 5.

Test much compressed, broadly ovate; chambers numerous, elongate, alternating, much the broadest near the peripheral end; sutures slightly depressed, very oblique; surface ornamented with numerous fine longitudinal costae, except the last-formed one or two chambers, which are smooth, at least at the apertural end; aperture radiate.

Length 0.40–0.65 mm.; breadth 0.22–0.30 mm.; thickness 0.05–0.06 mm.

Type specimen from the Lower Oligocene, Mint Spring marl, Mint Spring Bayou, Vicksburg, Miss. It is also known from the Byram marl of Byram, Miss.

This species is an unusual one for this genus, appearing much more like a *Bolivina*, but it has the characteristic aperture of *Polymorphina*. It is perhaps most closely related to *Polymorphina complanata* d'Orbigny.

POLYMORPHINA FRONDEA (Cushman)

Plate 30, figures 11 *a*, *b*

Bolivina frondea CUSHMAN, U. S. Geol. Survey Prof. Paper 129–F, 1922, p. 126, pl. 29, fig. 3; Prof. Paper 133, 1923, p. 20.

Polymorphina frondea CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 41.

Test compressed, of uniform thickness, the broad sides nearly parallel, oblong, broadest above the middle, acuminate toward the initial end, margins with a raised rim; chambers compressed, elongated, alternating; sutures depressed, distinct; wall smooth, often with obscure fine costae; aperture radiate.

Length 0.50–0.65 mm.; breadth 0.30–0.40 mm.; thickness 0.04–0.05 mm.

Polymorphina frondea is one of the most clearly marked species of *Polymorphina*. Its raised margins are very characteristic, and no other known species has such margins. Otherwise, it is closely related to *Polymorphina advena*, which is always ornamented on its surface and has a rounded periphery.

Distribution.—The species is characteristic of the lower Oligocene of the Coastal Plain region of the United States; Byram marl, Byram, Miss.; Glendon limestone, below waterfall in Glass Bayou, Vicksburg, Miss.; west bank of Conecuh River at McGowan's Bridge, about 1 mile below the mouth of the Sepulga River, Ala.; Marianna limestone, bluff east of small branch about 1½ miles northeast of Brandon, Miss.; Mint Spring marl, Chickasawhay River, 1¼ miles northwest of mouth of Limestone Creek, 4 miles northwest of Waynesboro, and 1½ miles southwest of Boice, Miss.; Red Bluff clay, St. Stephen's Bluff, right bank of Tombigbee River, about 9 miles above Jackson, Ala.

POLYMORPHINA CHARLOTTENSIS Cushman

Plate 31, figures 1–6

Polymorphina charlottensis CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 1, 1925, p. 41, pl. 6, fig. 9.—CUSHMAN and OZAWA, Jap. Journ. Geol. and Geogr., vol. 6, 1929, p. 72, pl. 13, fig. 8; pl. 15, figs. 11, 12; pl. 16, fig. 1.

Polymorphina compressa CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 89, pl. 40, fig. 3.

Polymorphina complanata BAGG (not d'Orbigny), Bull. 513, U. S. Geol. Survey, 1912, p. 69, pl. 20, figs. 13, 14.

Polymorphina biserialis GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 53, pl. 9, fig. 4.

Polymorphina elongata GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 54, pl. 9, fig. 7.

Test elongate, more or less compressed, tapering slightly from the broadly rounded initial end, edges more or less angular; chambers compressed, not much elongated, arranged at first in a clockwise, sigmoid series in the microspheric form, but in an almost alternating biserial series in the megalospheric form, each succeeding chamber removed much farther from the base; sutures not depressed, generally limbate and distinct; wall smooth, translucent; aperture radiate.

Maximum length, 3.10 mm.; breadth, 0.85 mm.; thickness, 0.30 mm.

Polymorphina charlottensis is generally very large, attaining 3 millimeters in length. Bagg described and figured the present spe-

cies under the name *Polymorphina complanata* d'Orbigny, but the two have almost no features in common excepting the alternating chambers.

Cushman described and figured the microspheric form of the present species from British Columbia.

To the same form Galloway and Wissler later gave the name *Polymorphina elongata*, which is considered by them to be the same as Bagg's *Polymorphina compressa*, but Bagg's *P. compressa* has depressed sutures and more rounded chambers, the characteristics of *Pseudopolymorphina*, and is quite different from Galloway and Wissler's *P. elongata*. Moreover, *P. elongata* is preoccupied by Fornasini in 1902.

Polymorphina biserialis Galloway and Wissler, reported from the Pliocene of Timms Point, Calif., is evidently a full-grown specimen of the present species.

Distribution.—*Polymorphina charlottensis* is a species limited to the Pacific as far as known. It is only known from the late Tertiary and as a Recent species. We have specimens from the following localities:

Recent.—Queen Charlotte Sound, British Columbia, 25 fathoms. *Albatross* D 4825, D 4826, D 4878 off Japan, 84–114 fathoms.

Pleistocene.—Lomita Quarry, Palos Verdes Hills, California.

Pliocene.—Timms Point, San Pedro, California. Natsukawa, Province of Echigo, Japan.

POLYMORPHINA LINGULATA Stache

Plate 31, figures 7 *a*, *b*

Polymorphina lingulata Stache, *Novara* Exped., Geol. Theil, vol. 1, Abt. 2, 1864, p. 255, pl. 24, fig. 1 *a*, *b*.

Polymorphina sacculus Stache, *Novara* Exped., Geol. Theil, vol. 1, Abt. 2, 1864, p. 259, pl. 24, fig. 6 *a*, *b*.

Polymorphina pernaeformis Stache, *Novara* Exped., Geol. Theil, vol. 1, Abt.2, 1864, p. 256, pl. 24, fig. 2 *a*, *b*.

Polymorphina gigantea Stache, *Novara* Exped., Geol. Theil, vol. 1, Abt. 2, 1864, p. 262, pl. 24, fig. 9 *a*, *b*.

Polymorphina cognata Stache, *Novara* Exped., Geol. Theil, vol. 1, Abt. 2. 1864, p. 257, pl. 24, fig. 3 *a*, *b*.

Polymorphina contorta Stache, *Novara* Exped., Geol. Theil, vol. 1, Abt. 2, 1864, p. 257, pl. 24, fig. 4 *a*, *b*.

Polymorphina marsupium Stache, *Novara* Exped., Geol. Theil, vol. 1, Abt. 2, 1864, p. 258, pl. 24, fig. 5 *a*, *b*.—Chapman, New Zealand Geol. Surv., Pal. Bull. No. 11, 1926, p. 68, pl. 5, fig. 5.

Polymorphina regularis Münster var. *lingulata* Chapman, New Zealand Geol. Surv., Pal. Bull. No. 11, 1926, p. 67, pl. 5, figs. 1, 3, 4, 6.

Polymorphina regularis Münster var. *pernaeformis* Chapman, New Zealand Geol. Surv. Pal. Bull. No. 11, 1926, p. 67, pl. 5, fig. 2.

Polymorphina regularis Chapman, New Zealand Geol. Surv., Pal. Bull. No. 11; 1926, p. 67, pl. 5, fig. 9 *a*, *b*.

Test compressed, oval (young) to oblong (adult), tapering toward both ends; chambers elongated, alternating, arranged in a nearly

biserial series from the start; sutures not depressed, limbate, distinct; wall smooth; aperture radiate.

Ozawa examined the original specimens of *P. lingulata, P. pernaeformis, P. cognata, P. contorta, P. marsupium,* and *P. sacculum* deposited in the department of geology and paleontology, Museum of Natural History of Vienna, and is convinced that the difference among these species is not more than the range of variation of individuals of one species.

We have no specimens like the present species. It closely resembles *P. charlottensis* found in the Pacific, but the test is much broader, consisting of elongated chambers. *Polymorphina subrhombica* from the lower Eocene of New Jersey appears to be very close to *Polymorphina lingulata,* but it has straight sutures, wider chambers and a more compressed test.

Distribution.—Stache's species were from the Tertiary of New Zealand.

POLYMORPHINA SCHLUMBERGERI Cushman and Ozawa, new species

Plate 31, figures 8 *a, b*

Test compressed, fusiform in outline, rather obtuse at both ends, margin even, periphery rounded; chambers compressed, elongated, arranged at first in a contraclockwise, sigmoid series, later becoming regularly biserial; sutures not depressed, distinct; wall smooth, rather thick, polished; aperture radiate.

Length of holotype 0.90 mm.; breadth 0.50 mm.; thickness 0.20 mm.

Holotype.—(Cushman Coll. No. 11791.) From the Miocene, Aquitanian superieur, St. Avit, near Mont de Marsan, France.

In its arrangement of chambers it is very similar to *Polymorphina fornasinii,* but it has a rather obtuse end, the sutures not depressed, and the later chambers more elongate.

POLYMORPHINA HOWCHINI Cushman and Ozawa, new species

Plate 31, figures 9 *a, b*

Test elongated, compressed, broadly rounded at the base, more or less tapering toward the obtuse apertural end; periphery rounded; chambers, much longer than broad, slightly inflated, overlapping, alternating in a biserial series; sutures very little depressed, not very distinct; wall thick, partly ornamented by numerous fine costae better developed near the base; aperture large, radiate.

Length of holotype 2 mm.; breadth 1.05 mm.; thickness 0.45 mm.

Holotype.—(Cushman Coll. No. 9771.) From the Lower Pliocene, McDonalds, Muddy Creek, Hamilton, Victoria, Australia.

The present species is fairly large, and in general outline it resembles *Polymorphina frondiformis* from the Crag of England, but it is much

thicker and the numerous costae, although only partly developed, are much finer. It is named for Rev. W. Howchin, of Australia.

POLYMORPHINA FRONDIFORMIS Searles Wood

Plate 31, figures 10 *a*, *b*

Polymorphina frondiformis Searles Wood, in Morris, Catal. Brit. Fossils, 1843, p. 62.—Jones, Parker, and H. B. Brady, Crag. Foram., Pal. Soc., vol. 19, 1866, App. i, ii (footnotes), pl. 1, figs. 62, 63, 69.—H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 241, pl. 41, figs. 33 *a–c*.—Jones, Foram. Crag., pt. 3, 1896, p. 271, pl. 1, figs. 62, 63; pl. 4, figs. 11–14.

Test elongate, oval, greatest breadth above the middle, more acute toward the base than the apertural end; chambers elongate, compressed, not much embracing, arranged in an entirely biserial series, each succeeding chamber removed much farther from the base; wall rather thick, ornamented with irregular, rough, longitudinal costae, interrupted at the sutures, sometimes almost smooth; sutures but little depressed, not very distinct; aperture radiate.

Our largest specimen measures, length 3.40 mm.; breadth 1.60 mm.; thickness 0.30 mm.

Polymorphina frondiformis with generally large dimensions is one of the most specialized and well-defined species of the genus. Its surface ornamentation is not definite, but is usually present to a greater or less extent. It consists of circular or oval beads or of more or less interrupted costae distributed unequally in a longitudinal direction over the flat sides of the test.

Distribution.—The present species appears to be limited to the Crag in England, in which it is rather common. Searles Wood first reported it from the Crag at Sutton, near Colchester, where our specimens were also obtained. Brady, Parker, and Jones record it from the Coralline Crag of East Anglia.

Genus SIGMOMORPHINA Cushman and Ozawa, 1928

SIGMOMORPHINA NYSTI (Reuss)

Plate 32, figures 1 *a*, *b*

Polymorphina regularis Münster var. *nysti* Reuss, Bull. Acad. Roy. Sci. Belg., sér. 2, vol. 15, 1863, p. 152, pl. 3, fig. 42.

Test compressed, lanceolate, greatest breadth in the upper half, tapering toward the base, margin angulate; chambers elongated, arranged in an open, clockwise, sigmoid series, each succeeding chamber removed much farther from the base; sutures not depressed, almost straight, distinct; wall smooth; aperture radiate.

Length of figured specimen 1.15 mm.; breadth 0.45 mm.; thickness 0.20 mm.

The present species is described by Reuss as a variety of *Polymorphina regularis* and the varietal name "*nysti*" is only used in the explanation of the figure. It is related to the German Oligocene species *S. regularis* in some features, but the present species has shorter and noninflated chambers and the test is narrower with straight sides.

Distribution.—Reuss recorded this species from the Crag of Antwerp. We have found it in the Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France, a specimen from this locality being figured here.

SIGMOMORPHINA JACKSONENSIS (Cushman)

Plate 32, figures 2 *a*, *b*

Polymorphina jacksonensis CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, 1926, p. 35, pl. 5, figs. 5 *a*, *b*.

Polymorphina compressa NUTTALL, Quart. Journ. Geol. Soc., vol. 84, 1928, p. 93, pl. 6, figs. 18, 19.

Test broad and compressed, periphery broadly rounded, apertural end narrowed to a slightly produced aperture; chambers elongate, slightly inflated, embracing, arranged in a contraclockwise, sigmoid series, each succeeding chamber removed farther from the base; sutures very slightly depressed, distinct, almost straight; wall thick, smooth; aperture radiate.

Maximum length 1.10 mm.; breadth 0.65 mm.; thickness 0.25 mm.

Sigmomorphina jacksonensis more or less resembles *S. regularis* in some features, but the latter has more inflated chambers arranged in a clockwise, sigmoid series.

Distribution.—The type locality for this species is near Blue Springs, Jackson County, Fla. The other localities of our specimens are as follows: Upper Eocene, Jackson, Miss. Jackson, west bank of Chickasawhay River, 1½ miles south of Shubuta, Wayne County, Ala.; on small stream entering Conecuh River, NE. ¼ sec. 6, T. 3 N., R. 15 E., 1 mile east of Beck, Covington County; about 3½ miles southeast of Cullomburg, road from Bladen Springs to Millry. Cocoa sand, Cocoa post office. Ocala limestone, branch at road in sec. 7, T. 6 N., R. 6 E., 1½ miles southwest of Perdue Hill, Monroe County, Ala. Barnwell sand, Barnwell County, S. C. Claiborne, Lisbon formation, 1 mile north of Watubbee Station, Clarke County, Miss. It occurs at numerous other Claiborne localities not listed here. Trinidad, Mount Moriah beds, Vistabella quarry.

SIGMOMORPHINA JACKSONENSIS (Cushman) var. COSTIFERA (Cushman)

Plate 32, figurse 3 *a*, *b*

Polymorphina jacksonensis CUSHMAN var. *costifera* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, 1926, p. 35.

Variety differing from the typical in the ornamentation of the test, which in the variety has several rounded longitudinal costae on the

basal portion of the test, sometimes covering a large portion of the surface. As a rule the variety and the typical form do not occur together, although both occur at Jackson, Miss., and at a station 1 mile east of Beck, Covington County, Ala.

Maximum length 1.20 mm.; breadth 0.50 mm.; thickness 0.13 mm.

Distribution.—The localities of the variety in our collection are all from the upper Eocene. Jackson formation, Mississippi, roadside on hill above pumping station, Jackson; Bluff on Garlands Creek, about 5 miles northeast of Shubuta, Clarke County; large ravine about 1 mile south of Yazoo City, Yazoo County. Alabama, east bank of Sepulga River, about 4 miles northeast of Brooklyn, Conecuh County; road from Perdue Hill to Claiborne, Monroe County; bank of small stream entering Conecuh River, northeast ¼ sec. 6, T. 3 N., R. 15 E., 1 mile east of Beck, Covington County. Georgia, Rich Hill, Crawford County, 6 miles southeast of Roberta. Florida, road near Blue Springs, Jackson County. South Carolina, Barnwell sand, Barnwell County.

A few specimens evidently of this variety are from the Gosport sand of the Claiborne, near Claiborne, Ala.

SIGMOMORPHINA CHAPMANI (Heron-Allen and Earland)

Plate 32, figures 4, 5

Polymorphina chapmani Heron-Allen and Earland, Journ. Roy. Micr. Soc., 1924, p. 163, pl. 10, figs. 60–63.

"Test compressed, sharp at the marginal edges; thickest at a point between the edge and the median line, which is somewhat depressed; consisting of 4 to 6 pairs of chambers, rapidly increasing in size, arranged alternately on each side of the median line. The whole shell has a *spiral twist* to the extent of about a quarter of a convolution on this median axis. Sutures flush and obscure but thick. Aperture typical but inconspicuous. Not infrequent and one of the most striking forms in the deposits. Its structure is very obscure, but it appears to represent a thin and sharply carinate and twisted form of *P. humboldti* Bornemann. Length 0.80–1.50 mm."

Distribution.—Janjukian, "Filter quarry," Batesford, Victoria, Australia.

Sigmomorphina chapmani is one of the best defined species among the genus. We have examined material from Filter quarry, but no specimen of this species was found; therefore Heron-Allen and Earland's description is cited above, and their figures are copied here.

SIGMOMORPHINA NUTTALLI Cushman and Ozawa, new species

Plate 32, figures 6 *a*, *b*

Test compressed, more or less inflated in the median, longitudinal area, rounded at the base, periphery somewhat acutely edged;

chambers elongated, arranged in a clockwise, sigmoid series, each succeeding chamber much farther removed from the base; sutures not depressed, distinct; wall smooth; aperture radiate.

Length of holotype 0.90 mm.; breadth 0.45 mm.; thickness 0.20 mm.

Holotype.—(Cushman Coll. No. 11799.) From the Eocene, Mount Moriah beds, yellow sandy clay overlying orbitoidal limestone, Vistabella quarry, Trinidad, British West Indies.

In general features it is very similar to *S. jacksonensis*, but the sigmoid arrangement of chambers in the present species is clockwise, while in *S. jacksonensis*, it is contraclockwise. We have no specimens of *S. jacksonensis* having a clockwise arrangement of chambers. The species from Trinidad, although they are represented by but few specimens, are clockwise. Therefore the Trinidad specimens are separated from the Jackson species, and the specific name *nuttalli* is given for Dr. W. L. F. Nuttall who has described many species from Trinidad.

SIGMOMORPHINA FLINTII (Cushman)

Plate 32, figures 7 *a–c*

Polymorphina flintii CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 155, pl. 40, fig. 10.

Test oval or somewhat rhomboidal, compressed, margin more or less angulate; chambers elongated, slightly inflated, arranged in a clockwise, sigmoid series, each succeeding chamber removed farther from the base; sutures distinct, but very slightly depressed; wall smooth, thick; aperture radiate.

Maximum length, 2.50 mm.; breadth, 1.35 mm.; thickness, 0.55 mm.

This is a large well-characterized species in its more or less compressed test, consisting of elongated chambers arranged in a clockwise sigmoid series.

Distribution.—This species occurs at a large number of *Albatross* stations off the eastern coast of the United States at depths ranging from 56–72 fathoms. Somewhat similar specimens occur in the upper Pliocene of Natsukawa, Province of Echigo, Japan, and in the Miocene, Janjukian, of Filter quarry, Batesford, Victoria, Australia.

SIGMOMORPHINA PSEUDOREGULARIS Cushman and Thomas

Plate 32, figures 8 *a–c*

Sigmomorpha (*Sigmomorphina*) *pseudoregularis* CUSHMAN and THOMAS, Journ. Pal., vol. 3, 1929, p. 178, pl. 23, figs. 5 *a–c*.

Polymorphina regularis STADNICHENKO (not von Münster), Journ. Pal., vol. 1, 1927, p. 231, pl. 38, figs. 18, 19.

Test large; length about twice the width and thickness a little more than half the width; median longitudinal ridge on both sides with sutures sloping backward, both right and left sets beginning at

right side of ridge, the left set crossing the ridge and bending in a gentle curve backward, while those on the right begin at the right of the ridge and extend backward in a more nearly direct fashion, both sets reaching the periphery and giving the shell only a semiequitant appearance, the two sides so nearly equal as to give a bilateral symmetry; aperture round, radiate, the apertural end showing four chambers.

Length of holotype, 0.70 mm.; width, 0.32 mm.; thickness, 0.12 mm.

Holotype.—Cat. No. 371021, U.S.N.M.

It differs from any other known *Sigmomorphina* in its strongly inflated longitudinal ridge developed in the portion corresponding to the line of the apertures of each of the sigmoid series of chambers.

Distribution.—Eocene, 17½ miles south of Palestine Road on Grapeland Road, first creek crossed by fording north of Grapeland, Houston County, Tex. It occurs in the Mount Selman and Cooks Mountain greensands of the Eocene of Texas.

SIGMOMORPHINA REGULARIS (v. Münster)

Plate 33, figures 1 *a*, *b*

Polymorphina regularis v. MÜNSTER, in ROEMER, Neues Jahrb. für Min., etc., 1838, p. 385, pl. 3, fig. 21.—REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 247, pl. 7, figs. 70–73.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1869, p. 229, pl. 40, figs. 13 *a–c.*—WELLER, Geol. Surv.New Jersey, Paleontology, vol. 4, 1907, p. 253, pl. 3, figs. 29–31.

Polymorphina anceps PHILIPPI, Beitr. Kennt. Tert. nordwest. Deutschlands, 1843, p. 41, pl. 1, fig. 34.—REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 246, pl. 6, fig. 68; pl. 7, fig. 69; vol. 50, abt. 1, 1864, p. 472, pl. 3, figs. 11, 12; pl. 4, figs. 1–3; Denkschr. k. Akad. Wiss. Wien, vol. 25, 1865, p. 155, pl. 4, figs. 9–11.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 223, pl. 39, fig. 8 *a–c.*

Polymorphina compressa PHILIPPI, Beitr. Kennt. Tert. nordwest. Deutschlands, 1843, p. 69, pl. 1, fig. 35.

Polymorphina humboldti BORNEMANN, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 347, pl. 18, figs. 7, 8.—H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 236, pl. 40, figs. 21 *a*, *b*.—REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 488.— v. SCHLICHT, Foram. Septar. Pietzpuhl, 1870, pl. 32, figs. 23–26, 29–32, 35–38.

Test oval (young) to oblong (adult), compressed, broadest in the upper half, margin angular; chambers compressed, long, arranged in a clockwise, sigmoid series, each succeeding chamber removed much farther from the base; sutures not depressed, limbate; wall smooth, translucent; aperture radiate.

Maximum length of our specimens, 2.70 mm.; breadth, 1.20 mm.; thickness, 0.65 mm.

This species has been described by German authors under different names as the above synonymy shows. This is not surprising;

and if we compare only the figures, we are easily led to separate them into many species.

Roemer's figures of *Polymorphina regularis* are fairly well drawn and show the characteristics of the species—a clockwise sigmoid arrangement of chambers, each succeeding chamber removed farther from the base. Accordingly, the side view shows that on the right side more than two-thirds of the surface is occupied by a series of regularly arranged, not much embracing, elongate chambers, while on the left is a series of a lesser number of much embracing, wide, and short chambers.

Bornemann's figures of *Polymorphina humboldti* appear to be more inflated than *Polymorphina regularis*, but all of Bornemann's specimens are few chambered and undoubtedly represent young stages of the present species as his measurements show. Bornemann's specimens measure from 0.6 mm. to 1.5 mm. in length while Roemer's specimen having numerous chambers is much larger, attaining almost 3 mm. in length. We have a good series of the species from young to adult obtained from Cassel, Germany.

Strictly speaking, it is not certain whether or not Reuss's *Polymorphina regularis* is the same as that figured by Roemer, because, when he described *Polymorphina anceps* Philippi in 1855 [10] he placed under its synonymy the *Polymorphina regularis* described by him in 1851 and *Polymorphina compressa* Philippi not *Polymorphina regularis* v. Münster in Roemer. Moreover, he gave the precedence to *Polymorphina anceps* described later than *Polymorphina regularis*. However, his figures of *Polymorphina anceps* in the same paper are all given the name of *Polymorphina regularis*. Reuss's figures show that his *Polymorphina anceps* or *regularis* has the chambers regularly alternating in a biserial series as in *Polymorphina compressa* and *P. anceps* reported by Philippi, and as far as his figures are concerned his species as well as Philippi's *Polymorphina anceps* differs from either *Polymorphina regularis* v. Münster or *Polymorphina humboldti* Bornemann.

We have examined a large number of specimens obtained from the Oligocene deposits of various localities in Germany, but could not find any specimen like Philippi's *Polymorphina anceps* which, according to Reuss, is not rare. Therefore it may be supposed that *Polymorphina anceps* is the same as *Polymorphina regularis*, and the figures of the species given by Philippi and Reuss are much conventionalized according to their conception of the Polymorphinidae. Specimens having a sigmoid arrangement of chambers are very often mistaken by various authors and not well drawn.

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[10] Zur Fauna des deutschen oberoligocens etc., p. 38.

Distribution.—*Sigmomorphina regularis* is one of the specialized species and appears to be limited to the German Oligocene and possibly the Cooper marl of the United States. We have specimens from the following localities:

Oligocene.—Germany, Ahnatal, near Cassel (abundant); Hermsdorf, near Berlin; Doberg, near Bünde; Escherhausen; Düsseldorf; Dickholzen, Hildesheimeswald.

Upper Eocene.—Cooper marl, United States, Cooper River, S. C.; pit on United States Highway No. 17 about 1 mile south of Moncks Corner, Berkeley County, S. C.

SIGMOMORPHINA FRONDICULARIFORMIS (Galloway and Wissler)

Plate 33, figures 2 *a*, *b*

Polymorphina frondiculariformis GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 55, pl. 9, fig. 6.

Sigmomorpha (*Sigmomorphina*) *frondiculariformis* CUSHMAN and OZAWA, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, pl. 2, fig. 12.—CUSHMAN, Special Publ. No. 1, Cushman Lab. Foram. Res., 1928, pl. 27, fig. 12.—CUSHMAN and OZAWA, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 81, pl. 17, fig. 23.

Frondicularia inaequalis BAGG (not Costa), Bull. 513, U. S. Geol. Survey, 1912, p. 60, pl. 18, figs. 1, 2.

Test elongate, lanceolate, compressed, the initial end with a prominent spine; chambers elongated, compressed, arranged in a contraclockwise sigmoid series, each succeeding chamber only slightly removed from the base; sutures slightly depressed, distinct; wall smooth; aperture produced, radiate.

Maximum length 2 mm.; breadth 0.70 mm.; thickness 0.20 mm.

The present species is one of the well defined species of the genus. Its elongated chambers arranged in an open sigmoid series and its strong initial spine are the characteristics of the species by which it is easily distinguished from others of the genus.

Distribution.—This species is only known from the later Tertiary in California and Recent off the coast. It is common in the upper Pliocene of Timms point, San Pedro, Calif., and rare in the Pleistocene of Lomita quarry, Palos Verdes Hills. We also have the species from off La Jolla, Calif.

SIGMOMORPHINA TORTA (Galloway and Wissler)

Plate 33, figure 3

Polymorphina torta GALLOWAY and WISSLER, Journ. Pal., vol. 1, 1927, p. 55, pl. 9, fig. 5.

Sigmomorphina torta CUSHMAN and OZAWA, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 81.

Test elongate, elliptical, acuminate toward the base, compressed and twisted, the initial end with a blunt spine; chambers elongate,

slightly twisted, not much embracing, arranged in a contraclockwise sigmoid series, each succeeding chamber removed farther from the base; sutures but little depressed, distinct; wall smooth; aperture produced, radiate.

Maximum length 1.50 mm.; breadth 0.35 mm.

Sigmomorphina torta is evidently related to *Sigmomorphina frondicula-riformis* from which it is derived by having the chambers shortened and more or less curved and accordingly the test is twisted. It is one of the most specialized species of the genus.

Distribution.—Galloway and Wissler described the species from the Pleistocene D. M. S. and B. quarry, Lomita, Palos Verdes Hills, and from the Pliocene of Timms Point, Calif. We have specimens from both localities, and also Recent specimens from off the southern California coast.

SIGMOMORPHINA SEMITECTA (Reuss)

Plate 33, figures 6, 7

Polymorphina semitecta REUSS, Sitz. Akad. Wiss. Wien, vol. 55, pt. 1, 1867, p. 91, pl. 3, fig. 10.

Polymorphina lucida D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 266, No. 18.—FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 10, 1902, p. 51, fig. 50 (in text).

Test compressed, oval to ovate, broadly rounded at the base, tapering toward the aperture; chambers elongate, arranged in a clockwise sigmoid series, all extending down to the base, but not involute; sutures scarcely depressed, distinct; wall smooth, the apertural end often with fistulose tubes; aperture radiate.

Length 0.55 mm.; breadth 0.37 mm.; thickness 0.12 mm.

The nearest ally of the present species is *Sigmomorphina undulosa*, which has elongated chambers arranged in a sigmoid series, but each succeeding chamber is much farther removed from the base and not extending down to the base, as in the present species.

Guttulina lucida d'Orbigny, figured by Fornasini, is undoubtedly a young specimen of the present species.

Distribution.—We have specimens referable to the present species from the following localities:

Miocene.—France, Aquitanien superieur, La Brede, Larriey. Hungary, Tortonian shell sand, Varpolata.

Eocene.—France, Lutetien, Parnes (Les Bôves).

SIGMOMORPHINA SEMITECTA (Reuss) var. TERQUEMIANA (Fornasini)

Plate 33, figures 4, 5; Plate 34, figures 2, 3; Plate 35, figure 1.

Polymorphina amygdaloides REUSS var. *terquemiana* FORNASINI, Mem. Accad. Istit. Sci. Bologna, ser. 5, vol. 9, 1900–1902 (1902), p. 72, fig. 25 (in text).

Polymorphina amygdaloides TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 141, pl. 14 (22), figs. 30, 31.

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Polymorphina pauperata TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 38, pl. 3 (8), figs. 11 *a* to 19.

Globulina varians TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 2, 1882, p. 128, pl. 13 (21), figs, 9–16.

Variety differing from the typical in its more elongate lanceolate test consisting of elongated chambers and more acute initial end.

Polymorphina pauperata Terquem, described from the Pliocene of the Isle of Rhodes, is a compressed lanceolate form having an acute initial end. It is a few-chambered specimen and resembles a compressed *Globulina*. We have several such specimens which are invariably small, and they appear to us to represent a young stage of the present variety. *Globulina varians* Terquem from the Eocene of Vaudancourt may be also placed under the present species, as far as his first and second figures are concerned.

Distribution.—We have specimens more or less typical from the following localities:

Recent.—Mediterranean, 10–14 fathoms, off the island of Delos.

Pliocene.—Italy, Castel Arquato.

Miocene.—France, Burdigalien inferieur, Le Coquillat, Leognan; Moulin de l'Eglise, Saucats.

Eocene.—France, Lutetien, Chaussy; Grignon. United States, Jackson, east bank of Sepulga River, about 4 miles northeast of Brooklyn, Conecuh County, Ala.; Rich Hill, Crawford County, Ga.

SIGMOMORPHINA SCHWAGERI (Karrer)

Plate 34, figures 1 *a–c*

Polymorphina schwageri KARRER, Abhandl. k. k. geol. Reichs., vol. 9, 1877, p. 384, pl. 16 *b*, fig. 43.

Polymorphina (*Guttulina*) *megapolitana* CLODIUS, Archiv. Ver. Fremde Nat. Mecklenburg, 75 Jahr., 1922, p. 126, pl. 1, fig. 9 *a–c*.

Polymorphina regularis HOSIUS, Ver. Nat. Hist. Vereins Pr. Rheinlande, vol. 50, 1893, p. 107, pl. 2, fig. 8.

Test elongate, equilateral, equally compressed on either side, margin rounded; chambers slightly inflated, not much overlapping, arranged in a clockwise sigmoid series, each succeeding chamber removed farther from the base; sutures but little depressed, distinct; wall thick, smooth; aperture radiate.

Length of figured specimen 1.80 mm.; breadth 0.95 mm.; thickness 0.30 mm.

Karrer's *Polymorphina schwageri* is fairly well drawn in its sigmoid arrangement of chambers, although he did not describe it correctly. It is a well-defined species, and there is no other to be confused with it. *Sigmomorphina regularis* has the same arrangement of chambers, but it is more compressed, especially on the margin.

Polymorphina megapolitana, described by Clodius from the Miocene of Mecklenburg, is placed under the present species although it has a spine at the initial end.

Distribution.—The present species seems to be limited to the later Tertiary in Europe. Karrer described it from Lapugy in Siebenburgen. Clodius's specimens are also from the Miocene. We have it from the Crag of Sutton, England, and from the Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. A form very similar to this occurs in the upper Pliocene, Natsukawa limestone, Natsukawa, Province of Echigo, Japan.

SIGMOMORPHINA UNDULOSA (Terquem)

Plate 34, figures 4, 5

Polymorphina amygdaloides TERQUEM (not Reuss), Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 39, pl. 3 (8), figs. 22, 25 (not 23, 24, 26–30).
Polymorphina undulosa TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 41, pl. 3 (8), figs. 35 *a*, *b*, (not 36).

Test oval to ovate, compressed; chambers elongated, embracing, arranged in a contraclockwise sigmoid series, each succeeding chamber not much removed from the base; sutures depressed, distinct; wall smooth, rather thin, often covered with fistulose tubes; aperture radiate.

Maximum length 0.60 mm.; breadth 0.30 mm.; thickness 0.15 mm.

This species is undoubtedly related to *Guttulina lactea*, from which it is derived by losing the quinqueloculine arrangement of chambers and becoming sigmoidal. The direction of the sigmoid arrangement of chambers appears not to be definitely fixed, and rarely there are some specimens showing a clockwise sigmoid arrangement of chambers.

Some figures of *Polymorphina amygdaloides* Terquem (the first figure of the species, 22, and fig. 25, ? 26), described in 1878, coincide with the present species, but the specific name *amygdaloides* is preoccupied by Reuss in 1856 (*Globulina amygdaloides* Reuss in 1851); therefore *undulosa* is chosen for the present species.

Distribution.—*S. undulosa* occurs in European late Tertiary deposits as well as in the Recent state. We have specimens of the species from the localities listed below:

Recent.—Atlantic, *Lord Bandon*, dredgings southwest of Ireland; coast of Iceland; coast of Brazil; Dry Tortugas, Fla., 18 fathoms.

Pliocene.—England, Crag of Sutton.

SIGMOMORPHINA LAMARCKI Cushman and Ozawa, new species

Plate 34, figures 6 *a–c*

Test oval, rounded at the base, obtuse at the apertural end, compressed, periphery rounded; chambers much longer than wide,

slightly compressed, slightly embracing, arranged in a clockwise sigmoid series, each succeeding chamber farther removed from the base; sutures somewhat depressed, distinct; wall entirely ornamented by numerous fine costae, rather thick; aperture radiate.

Length of holotype 0.62 mm.; breadth 0.32 mm.; thickness 0.15 mm.

Holotype.—(Cushman Coll. No. 11840.) From the Eocene (Lutetien), Campbon, France.

The general outline is very similar to *Sigmomorphina semitecta*, but it is ornamented and the test has a tendency to elongate. The specific name is given for Lamarck.

SIGMOMORPHINA PEARCEYI Cushman and Ozawa, new species

Plate 35, figures 2, 3

Polymorphina inflata PEARCEY, Trans. Roy. Soc. Edinburg, vol. 49, 1914, p. 1,023, pl. 2, figs. 14–16.

Test elongate, clavate, the greatest breadth in the upper half, tapering toward the base, apertural end rounded; chambers more or less compressed, early ones elongated, later becoming rounded, generally the last one much inflated and large, arranged in a contraclockwise sigmoid series, each succeeding chamber, especially the last one or two, removed farther from the base; sutures depressed, distinct; wall smooth, thin, translucent; aperture near the center of the last chamber, with short entosolenian tube.

Length of largest specimen 0.80 mm.; breadth 0.50 mm.; thickness 0.45 mm.

Holotype.—(Cushman Coll. No. 11841.) From off Dry Tortugas, Fla., 18 fathoms.

The later chambers of the present species tend to become more circular and are removed farther from the base, yet they are arranged in a sigmoid series. This species is well characterized and for the first time described by Pearcey under the name "*Polymorphina inflata*," but the name is preoccupied first by Zittel in 1876, and secondly by Terquem in 1886. Zittel's *Polymorphina inflata* is apparently a mistake for *P. lactea* Williamson, as explained by Sherborn. *Globulina inflata* Reuss is different from either Zittel's or Terquem's *P. inflata*.

We can not use the specific name "*inflata*" for the present species; therefore "*pearceyi*" is proposed for Pearcey, the first recorder of the species.

Distribution.—It is a very rare species. Pearcey recorded it from the Scottish Antarctic Expedition collections. We have one specimen from the Eocene of Val di Lonte, Italy, and two specimens from the Atlantic, off Gaspé, between Ship Head and Cape Bonne Ami, 30 fathoms, and off the Tortugas, Fla., 18 fathoms. The range of these three specimens seems to show that even though they seem very much alike, more material may show that these are not all the same.

SIGMOMORPHINA CRASSA (Roemer)

Plate 35, figures 4, 5

Polymorphina crassa ROEMER, Neues Jahrb. f. Min. etc., 1838, p. 385, pl. 3, fig. 27.—REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 250, pl. 8, fig. 82.

Polymorphina crassatina v. MÜNSTER, Neues Jahrb. f. Min., etc., 1838, p. 385, pl. 3, fig. 30.

Guttulina robusta REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 246, pl. 6, fig. 65.

Polymorphina problema D'ORBIGNY var. *deltoidea* REUSS, Denkschr. k. Akad. Wiss. Wien, vol. 25, 1865, p. 154, pl. 4, fig. 8.

Polymorphina insignis REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855 (1856), p. 248, pl. 7, figs. 74, 75.

Test broadly oval to oblong, greatest width above the middle; chambers inflated, arranged at first in a quinqueloculine series, becoming biserial later, each succeeding chamber removed much farther from the base; sutures depressed, distinct; wall thick, smooth; aperture radiate.

Maximum length 2.25 mm.; breadth 1.60 mm.; thickness 0.45 mm.

Sigmomorphina crassa is fairly large, and even a young specimen, which may closely resemble *Guttulina problema* in general features, is much larger than an adult of that species. This circumstance has led Reuss to give the present species several specific names in different stages of growth. Our study of a large number of specimens obtained from the German Oligocene, showed that Reuss's *Polymorphina problema* var. *deltoidea* is a young phase of *P. crassa*. His *Guttulina robusta*, together with *Polymorphina* (*Guttulina*) *crassatina* Münster, has one more chamber added. *Polymorphina insignis*, a very large specimen attaining to 2.6 mm. in length, is the adult and has the later chambers arranged in a sigmoid series as in *Sigmomorphina crassa* (Roemer).

Distribution.—The present species seems to be restricted to the German Oligocene where specimens are fairly common. We have abundant specimens from the upper Oligocene of Ahnatal, near Cassel, Germany.

SIGMOMORPHINA SCHENCKI Cushman and Ozawa, new species

Plate 35, figures 6 *a*, *b*

Test compressed, broadly ovate, greatest breadth near the base; chambers elongated, embracing, arranged in a clockwise sigmoid series, each succeeding chamber slightly removed from the base; sutures not depressed, distinct; wall rather thick, smooth; aperture radiate.

Length of holotype 1.20 mm.; breadth 0.90 mm.; thickness 0.40 mm.

Holotype.—(Cushman Coll. No. 10147.) From the Oligocene (Keasey shale), Oregon.

In the general outline, it resembles Japanese Pliocene *Sigmomorphina kotoi*, but it is much larger and the chambers broader compared with the length. It more or less resembles *Sigmomorphina crassa* from the German Oligocene, but it has an advanced sigmoid arrangement of chambers, and the chambers are much elongated.

The species is named for Dr. H. G. Schenck of the Geological Department of Stanford University.

SIGMOMORPHINA KOTOI Cushman and Ozawa, new species

Plate 35, figures 7 *a*, *b*

Test compressed, ovate, broadly rounded at the base, tapering toward the aperture, periphery somewhat angulate; chambers more or less compressed, elongated, arranged in a clockwise sigmoid series, each succeeding chamber slightly removed from the base; sutures not depressed, distinct; wall smooth, translucent; aperture radiate.

Length of holotype 0.65 mm.; breadth 0.40 mm.; thickness 0.17 mm.

Holotype.—(Cushman Coll. No. 11848.) From the upper Pliocene, Natsukawa, in Province of Echigo, Japan.

The characteristic feature of the present species is its ovate test composed of elongated chambers which extend down to the base. The species is named for Emeritus Prof. B. Koto, Imperial University of Tokyo, Japan.

Distribution.—Known only from the upper Pliocene of Japan.

SIGMOMORPHINA TRINITATENSIS Cushman and Ozawa, new species

Plate 36, figures 1, 2

Test elongated, greatest breadth near the base, broadly rounded at the base, uniformly tapering toward the acute apertural end; chambers elongated, more or less cylindrical, embracing, arranged in a clockwise sigmoid series; sutures not depressed, distinct; wall rather thick, smooth; aperture radiate.

Length of holotype 1.45 mm.; breadth 0.90 mm.; thickness 0.55 mm.

Holotype.—(Cushman Coll. No. 11849.) From the Eocene, Hermitage quarry, Dumfries Road, Trinidad, British West Indies.

The elongated test, somewhat like an isosceles triangle in its side view, is very characteristic of the species.

Distribution.—In addition to the Trinidad specimens, we have a very similar specimen from the Eocene of Vincentown, N. J.

SIGMOMORPHINA BORNEMANNI Cushman and Ozawa, new species

Plate 36, figures 3 *a*, *b*

Polymorphina dilatata Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 83, pl. 6, fig. 49.

Test compressed, equilaterally triangular with rounded peripheries and angles, initial end slightly produced, margin thin and rather

acute; chambers compressed, elongate, arranged in a clockwise sigmoid series, each succeeding chamber not much removed from the base; sutures not depressed but distinct; wall smooth, thick; aperture radiate.

Length of figured specimen 0.90 mm.; breadth 0.75 mm.; thickness 0.40 mm.

Holotype.—(Cushman Coll. No. 11851.) From middle Oligocene, Hermsdorf, near Berlin, Germany.

Sigmomorphina bornemanni bears a close relationship to *S. regularis* and might be taken as a young stage of the latter, and naturally Reuss himself placed it under *Polymorphina anceps* (=*S. regularis*). If however, we compare the species with a young specimen of *Sigmomorphina regularis*, for example, such specimens as figured by Bornemann under the name of *P. humboldti*, it is not difficult to separate them. In *Sigmomorphina bornemanni* each succeeding chamber is added laterally and all chambers extend down almost to the base, while in *S. regularis*, even in its young stage, each succeeding chamber is removed from the base so that the test is much elongated. *Sigmomorphina bornemanni* might be considered to represent the microspheric form of *S. regularis*, but we have no evidence to assume it.

Polymorphina dilatata is preoccupied by d'Orbigny, therefore a new specific name *bornemanni* is given for Bornemann. It must be noticed here that *Guttulina dilatata* Reuss described from the Vienna Tertiary is different from the present species, although some authors have considered them the same.

Distribution.—Reuss described the present species from the Oligocene of Hermsdorf near Berlin where it occurs rarely. We have specimens from the original locality as well as from the Oligocene of Düsseldorf, and Ahnatal, near Cassel.

SIGMOMORPHINA GALLOWAYI Cushman and Ozawa, new species

Plate 36, figures 4 *a*, *b*

Test compressed, more or less twisted, oval in side view, caudate at the initial end; chambers elongated, slightly compressed, arranged in a contraclockwise sigmoid series, each succeeding chamber not much removed from the base; sutures but little depressed, distinct; wall smooth, rather thin, transparent; aperture radiate.

Length of holotype 0.90 mm.; breadth 0.55 mm.; thickness 0.22 mm.

Holotype.—(Cushman Coll. No. 11855.) From *Albatross* D4807, coast of Japan.

The twisted, compressed, oval test is characteristic of the species. Its nearest ally is *Sigmomorphina aliceae*, which is more elongated, and the chambers shorter and broader. This species is named for Dr. J. J. Galloway, of Columbia University.

Distribution.—Known only from off the coast of Japan.

SIGMOMORPHINA TRILOCULARIS (Bagg)

Plate 36, figures 5 *a–c*

Polymorphina trilocularis Bagg, U. S. Geol. Survey Bull. 513, 1912, p. 75, pl. 20, figs. 15–18.

Sigmomorpha trilocularis Cushman and Ozawa, Jap. Journ. Geol. Geogr., vol. 6, 1928, p. 74, pl. 16, fig. 5.

Test small, ovate, more or less rounded at the base, rather acute toward the apertural end; chambers much elongated and slender, roundly triangular in cross section, slightly embracing, arranged in a contraclockwise sigmoid series, each succeeding chamber removed from the base; sutures depressed, distinct; wall smooth, thin; aperture radiate.

Maximum length 0.90 mm.; breadth 0.35 mm.; thickness 0.20 mm.

Its elongated, slender chambers arranged in a more or less sigmoid series are the characteristics of the species. Its sigmoid arrangement of chambers is somewhat variable, and often it is closed, showing more or less a quinqueloculine series.

Distribution.—Only known in the North Pacific region as a late Tertiary fossil and as a Recent species. We have the species from the following localities:

Recent.—Off coast of southern California.

Pliocene.—Timms Point, San Pedro, Calif. Upper Pliocene, Natsukawa, Province of Echigo, Japan.

SIGMOMORPHINA YOKOYAMAI Cushman and Ozawa

Plate 36, figures 6 *a, b*

Sigmomorpha (*Sigmomorphina*) *yokoyamai* Cushman and Ozawa, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 18, pl. 1, fig. 16; Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 75, pl. 13, figs. 12–14; pl. 16, figs. 7, 8.

Test ovate, greatest breadth toward the base, tapering toward the apertural end, periphery sharply angled and carinate in the adult; chambers comparatively few in the megalospheric form, more numerous in the microspheric; chambers elongated and very narrow, arranged in an open sigmoid series and added so that the axis of each chamber is somewhat oblique giving a peculiar twisted appearance to the test; sutures distinct, very slightly depressed; wall thin, transparent, with longitudinal costae which are continuations from the ridges of the radiate apertures of each chamber, in some specimens with additional costae covering the entire surface; aperture radiate, terminal, somewhat produced into a cylindrical neck.

Length of holotype 0.93 mm.; breadth 0.50 mm.

This species is common and shows some variations in the surface ornamentation, some of the specimens being smooth except for the costae of the central portion, others being costate throughout. This is one of the most striking species of the Japanese collection and is

named for Dr. M. Yokoyama, who described the fossil mollusks from the same locality.

Distribution.—Our specimens are from the upper Pliocene of Sawane, island of Sado, and from Natsukawa, Province of Echigo, Japan.

SIGMOMORPHINA SAWANENSIS (Cushman and Ozawa)

Plate 38, figures 1 *a*, *b*

Sigmomorpha sawanensis CUSHMAN and OZAWA, Jap. Journ. Geol. Geogr., vol. 6, 1929, p. 74, pl. 16, fig. 6.

Test ovate, greatest breadth just above the base, tapering toward the apertural end; chambers numerous, elongate, about five times as long as broad in the adult, each chamber reaching nearly to the base, arranged in a contraclockwise sigmoid series; sutures distinct, slightly depressed; wall of medium thickness, smooth, translucent; aperture radiate.

Measurement of the holotype specimen: Length 0.76 mm.; breadth 0.33 mm.; thickness 0.25 mm.

This has a very much more elongate form than *Sigmomorphina sadoensis* and is more involute than that species, the chambers being very much longer and inclosing the earlier ones. It differs from the European *Sigmomorphina semitecta* in its more broadly rounded base.

Distribution.—The type specimens are from the upper Pliocene of Sawane, island of Sado, Japan. We have additional specimens from the upper Pliocene of Natsukawa, Province of Echigo, Japan.

SIGMOMORPHINA VAUGHANI Cushman and Ozawa, new species

Plate 38, figures 2 *a–c*

Test almost rhombic with three rounded angles and acute apertural angle, compressed, and more or less twisted, margin of the lower half, wavy; chambers compressed, elongated, arranged in a clockwise sigmoid series, each succeeding chamber farther removed from the base; sutures slightly depressed, distinct; wall smooth; aperture radiate.

Length of holotype 0.80 mm.; breadth 0.62 mm.; thickness 0.30 mm.

Holotype.—(Cat. No. 371262, U.S.N.M.) From the Eocene (Cooper marl) at Ingleside marl pit, Charleston, S. C. (U. S. Geol. Survey 6319).

It differs from *Sigmomorphina bornemanni* from the German Oligocene in its twisted test, wavy margins and more or less depressed sutures. This species is named for Dr. T. Wayland Vaughan of the Scripps Institution of Oceanography.

Distribution.—Upper Eocene, United States, Cooper marl. In addition to the type locality this species also occurs in the Cooper

marl of Cooper River, S. C. and in a pit on the United States Highway No. 17, about 1 mile south of Monck's Corner, Berkeley County, S. C.

SIGMOMORPHINA WILLIAMSONI (Terquem)

Plate 38, figures 3, 4

Polymorphina williamsoni TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 37.

Polymorphina lactea WALKER and JACOB var. *oblonga* WILLIAMSON, Recent Foram. Great Britain, 1858, p. 71, pl. 6, figs. 149, 149*a*.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 262, pl. 5, fig. 5.—CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1910, p. 413, pl. 55, fig. 12.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 147, pl. 40, figs. 7, 8.

Polymorphina compressa EGGER, Abhandl. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 309, pl. 9, figs. 11–13.

Polymorphina formosa Egger, Abhandl. kön. bay. Akad. Wiss., München, Cl. II, vol. 18, 1893, p. 440, pl. 9, figs. 17–19.

Polymorphina mucronata TERQUEM (not Terquem, 1878), Essai Class. Anim. Dunkerque, 1881, p. 130, pl. 17, fig. 3.

Polymorphina oblonga, H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 222, pl. 39, figs. 7*a*, *b*.—TERQUEM, Essai Class. Anim. Dunkerque, 1875, p. 37, pl. 5, fig. 11.—HERON-ALLEN and EARLAND, Proc. Roy. Irish Acad., vol. 31, pt. 64, 1913, p. 100, pl. 8, fig. 17.

Dimorphina millettii SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 145, pl. 5, figs. 15, 16.

Test ovate to oblong, compressed, of nearly equal thickness, sides nearly parallel, rounded at both ends; chambers elongated, embracing, arranged in a contraclockwise, sigmoid series, each succeeding chamber extending down to the base; sutures scarcely depressed, but distinct; wall smooth, thin, nearly transparent; aperture long, radiate, furnished with an entosolenian tube.

Maximum length 0.92 mm.; breadth 0.42 mm.; thickness 0.20 mm.

Sigmomorphina williamsoni is a well-marked species and is first recorded by Williamson from Southport, England, under the name "*Polymorphina lactea* var. *oblonga*." Brady, Parker, and Jones used the varietal name as the specific name, but much later Terquem changed the name "*oblonga*" to "*williamsoni*," as *oblonga* is preoccupied by d'Orbigny.

Polymorphina formosa Egger and *P. mucronata* Terquem, characterized by an oblong test with almost parallel peripheries, resemble the present species and can be included in it, although *P. mucronata* has a spine at the initial end.

Polymorphina compressa Egger (not Philippi, not d'Orbigny) is rather shorter than the typical specimen, but is to be placed in the synonymy of the present species.

Often the present species apparently shows an alternating chamber on one side on account of an incomplete overlapping of chambers, but the real arrangement of the chambers is always sigmoidal.

Dimorphina millettii, described by Sidebottom from off the east coast of Australia, 465 fathoms, having an elongated quadrangular test with a sigmoid arrangement of the chambers, is very similar to *S. williamsoni.* The difference is only an extra chamber which is added on the top of the main test. Such specimens, having a round extra chamber, are often found in shallow water off England and Belgium.

Distribution.—S. williamsoni appears to be rather common in the shallow water off England and Belgium, from where we have numerous specimens. Some forms very similar to the present species are reported from off east Australia. We also have a few fossil specimens which are something like the present species, but not enough material to be positive of the identification.

SIGMOMORPHINA CONCAVA (Williamson)

Plate 38, figures 5–7

Polymorphina lactea WALKER and JACOB var. *concava* WILLIAMSON, Recent Foram. Great Britain, 1858, p. 72, pl. 6, figs. 151, 152.

Excepting the last attached part, the test is oval and much compressed; chambers elongate, much embracing unequally on either side, each succeeding chamber extending down to the base, attached part (or chamber ?) generally highly convex, leaving a large space between the test and the foreign object, but without visible aperture; sutures not depressed, distinct; wall smooth, rather thin and almost transparent; aperture radiate.

Williamson was the first who noticed an unmistakably parasitic species of the Polymorphinidae which he named *Polymorphina concava.* We have several attached specimens, some of which are the same as that figured by Williamson. The present species is undoubtedly a specialized one among the Polymorphinidae. No other species having a test resembling that of *Sigmomorphina concava* is known, therefore Williamson's species is taken as a valid one.

Distribution.—Sigmomorphina concava seems to be extremely rare. Williamson gives Brixham, England, as the locality whence his specimens were obtained. We have specimens from off the Belgian coast, from the Mediterranean, and off the island of Delos, 10–14 fathoms. We have also a specimen here figured from the Pliocene of Monte Mario, near Rome.

SIGMOMORPHINA ALICEAE Cushman and Ozawa, new species

Plate 38, figures 8 *a, b*

Test oblong, compressed, twisted nearly 180°, greatest width in upper half, tapering toward the initial end; chambers elongated, especially the early ones, later ones becoming broader, compressed, not much embracing, arranged in a contraclockwise sigmoid series,

each succeeding chamber farther removed from the base; sutures but little depressed, distinct; wall of medium thickness, smooth; aperture radiate.

Maximum length 1.55 mm.; breadth 0.80 mm.; thickness 0.35 mm.

Holotype.—(Cat. No. 20856, U.S.N.M.) From *Albatross* D4805, off Japan.

Sigmomorphina aliceae is twisted, as is *S. torta*, from which it is quite distinct in its flat later chambers. In general appearance, it resembles *Sigmomorphina pearceyi*, but the latter has inflated chambers, and the test is not twisted as much as in the present species. The specific name is given for Alice E. Cushman, who took much care in preparing our manuscript and in checking our proofs.

Distribution.—Known only from off the coast of Japan.

Genus SIGMOIDELLA Cushman and Ozawa, 1928

SIGMOIDELLA ELEGANTISSIMA (Parker and Jones)

Plate 39, figure 1 *a–c*

Polymorphina elegantissima Parker and Jones, Phil. Trans., vol. 155, 1865, Table X, p. 438.—H. B. Brady, Parker, and Jones, Trans. Linn. Soc., vol. 27, 1870, p. 231, pl. 40, figs. 15 *b*, *c* (not *a*).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 566, pl. 72, fig. 13 (not figs. 12, 14, 15).—Flint, U. S. Nat. Mus. Rept., 1897, p. 319, pl. 67, fig. 4.—Bagg, Maryland Geol. Surv. (Eocene), 1901, p. 247, pl. 63, fig. 11; (Miocene), 1904, p. 476, pl. 133, fig. 3.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 90, pl. 38, fig. 1; U. S. Nat. Mus., Bull. 100, vol. 4, 1921, p. 267, pl. 54, figs. 1, 2.—Nuttall, Quart. Journ. Geol. Soc., vol. 84, 1928, p. 93, pl. 6, fig. 10.

Sigmoidella elegantissima Cushman and Ozawa, Jap. Journ. Geol. & Geogr., vol. 6, 1929, p. 76, pl. 16, figs. 10, 11.

Test compressed, almost circular excepting the slightly acute, apertural end, margins angular; chambers elongate, overlapping, arranged in a clockwise sigmoid series, each succeeding chamber becoming much larger and embracing those previously formed, but in old age specimens, the last one or two chambers not extending down to the base; sutures not depressed, but generally distinct; wall smooth; aperture radiate.

Maximum length 2 mm.; breadth 1.60 mm.; thickness 0.85 mm.

This beautiful species is only mentioned by Parker and Jones in 1864 and is first figured and described by H. B. Brady, Parker, and Jones in 1870. The species is discussed in detail in our paper on the Polymorphinidae found in Japan.

Distribution.—It is one of the most abundant species in warm seas of the Australian region extending into the Philippine region, where it is abundant, but not as far north as Japan, where it is replaced by *Sigmoidella kagaensis* Cushman and Ozawa. It occurs in the late Tertiary of the Australian and East Indian region. It is also com-

mon in the Tertiary of Trinidad, where numerous other species now living in the Indo-Pacific are found fossil. Our specimens represent the following localities:

Recent.—Pacific, Philippine expedition, *Albatross* D5143, vicinity of Jolo, 19 fathoms; D5145, off Jolo, 23 fathoms; D5146, 24 fathoms, D5148, 17 fathoms, both Sulu Archipelago, vicinity of Siasi; D5151, 24 fathoms, D5152, 34 fathoms, both Sulu Archipelago, off Tawi Tawi Group; D5178, 78 fathoms, D5179, 37 fathoms, both off Romblon; D5282, 248 fathoms, China Sea, off southern Luzon; D5318, 340 fathoms, China Sea, off Formosa; D5569, 303 fathoms, north of Tawi Tawi; D5580, 162 fathoms, Darvel Bay, Borneo; D2668, 9 fathoms, off Hongkong; Dusky Sound, New Zealand.

Pliocene.—Saloenia, Benkoelan, Sumatra.

Miocene.—Australia, Balcombian, lower beds, Muddy Creek, Victoria. Janjukian, soapy clay bed in polyzoal limestone, Danger Point, Torquay, Victoria. Green marl, Bird Rock cliffs, Torquay, Victoria; Filter Quarry, Batesford, Victoria. Trinidad, "*Sagrina* beds," Orapouche Lagoon, Trinidad Point; "*Uvigerina* bed," Cipero section; from oil-stained shales, just north of Point Bontour.

Oligocene.—Australia, Clifton Bank near Hamilton, Victoria.

Eocene.—Trinidad, Cipero section and Mount Moriah beds, yellow sandy clay, underlying orbitoidal limestone, Vistabella quarry.

SIGMOIDELLA KAGAENSIS Cushman and Ozawa

Plate 39, figures 2, 5

Sigmoidella kagaensis CUSHMAN and OZAWA, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 19, pl. 2, fig. 14; Jap. Journ. Geol. & Geogr., vol. 6, 1929, p. 76, pl. 13, fig. 15; pl. 16, fig. 9.

Polymorphina elegantissima H. B. BRADY, PARKER, and JONES, Trans. Linn. Soc., vol. 27, 1870, p. 231, pl. 40, fig. 15 *a*.

Test broadly ovate, base very broadly rounded, apertural end somewhat tapering, sides nearly parallel for more than half the length, compressed, periphery subacute; chambers elongate, narrow, five or six times as long as broad, arranged in an open, clockwise sigmoid form, resulting in a test in which, when viewed from either side, one elongate chamber appears at the left and all other visible chambers are in a series of gradually increasing length on its right, and involute; sutures very distinct, curved, not depressed, except on the growing edge, which is depressed; wall smooth, translucent; aperture terminal, radiate.

Length of holotype 1.50 mm.; breadth 0.70.; thickness 0.34 mm.

The arrangement of the chambers in the species is in many ways similar to that seen in *Sigmoilina* in the Miliolidae except that the aperture is always at one end. It is closely related to *Sigmoidella elegantissima*, but is a more elongate and narrow form and probably

represents a cool water relative of *Sigmoidella elegantissima* (Parker and Jones).

Distribution.—Our specimens represent the following localities:

Recent.—Off Japan, Kobama (abundant). *Albatross* D4883, 53 fathoms, about 20 miles southwest of Nagasaki entrance, Eastern Sea; Inland Sea. Philippines, D5143, 19 fathoms, off Jolo Jolo; D5311, 88 fathoms, China Sea, near Hongkong.

Pleistocene.—Japan, Alluvium, Kehi, Province of Tajima.

Pliocene.—Upper, Japan, Kumomya, Province of Totomi; Okuwa, Province of Kaga; Ono, Province of Kochi; Natsukawa, Province of Echigo. Lower Pliocene, Beaumaris, near Melbourne, Victoria, Australia.

Miocene.—Australia, Janjukian, polyzoal marl, overlying limestone, Filter quarries, Batesford, Victoria.

SIGMOIDELLA PLUMMERAE Cushman and Ozawa, new species

Plate 39, figures 3 *a*, *b*

Test compressed, ovate, broadly rounded at the base, acute toward the aperture, periphery angular; chambers elongated, more or less compressed, arranged in a contraclockwise sigmoid series, each succeeding chamber embracing the earlier one, but often the last chamber not extending down to the initial end; sutures not depressed, usually distinct; wall rather thin, smooth; aperture radiate.

Length of holotype 0.70 mm.; breadth 0.35 mm.; thickness 0.22 mm.

Holotype.—(Cushman Coll. No. 11879.) From the Eocene, Cooks Mountain formation, Smithville, Tex.

The main difference between the present species and *Sigmoidella elegantissima* is the sigmoid arrangement of chambers, that of the present species being contraclockwise, while that of *S. elegantissima* is clockwise.

Distribution.—It is common in the Eocene in the United States, especially in the Claiborne, but ranges from the Cooper marl to the Midway. We have it from numerous localities from South Carolina to Texas. The species is named for Mrs. Helen J. Plummer.

SIGMOIDELLA MARGARETAE Cushman and Ozawa, new species

Plate 39, figures 4 *a*, *b*

Test much compressed, ovate in outline, periphery very angular; chambers compressed, elongated, arranged in a contraclockwise sigmoid series, each succeeding chamber extending down to the base and embracing the earlier ones; sutures not depressed, distinct; wall smooth, rather thin; aperture radiate.

Length of holotype 0.50 mm.; breadth 0.25 mm.; thickness 0.10 mm.

Holotype.—(Cushman Coll. No. 11882.) From the upper Pliocene of Terao Miura, Japan. We have a single specimen from *Albatross* D4807 off Japan.

In its contraclockwise sigmoid arrangement of chambers and the general outline of the test it is similar to *Sigmoidella plummerae* from the Eocene of North America. However, compared with the American species, it is much more compressed, with a very angulate periphery and a thinner wall.

When we described *Sigmoidella elegantissima* in our recent paper we remarked that we had examined very many specimens which showed the sigmoid series of chambers clockwisely arranged, and a single specimen was found with a contraclockwise arrangement. Now we are convinced that this single specimen is not *Sigmoidella elegantissima,* but is quite distinct from that species in its much compressed test and more acute apertural end. This determination is confirmed by the occurrence of specimens having a contraclockwise arrangement of chambers in the Japanese late Tertiary.

The specific name is given for Miss Margaret S. Moore, who made all the drawings for the figures in this paper.

Genus GLANDULINA d'Orbigny, 1826

GLANDULINA LAEVIGATA d'Orbigny

Plate 40, figures 1 *a, b*

Nodosaria (*Glandulina*) *laevigata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 252, No. 1, pl. 10, figs. 1–3.

Glandulina laevigata D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 29, pl. 1, figs. 4, 5.

Test fusiform the initial end very acute and often with spine in the microspheric form, obtuse in the megalospheric form, circular in cross section; chambers inflated, much overlapping, arranged at first in a biserial series, abruptly becoming uniserial in the microspheric form, entirely uniserial in the megalospheric form; sutures not depressed, distinct; wall smooth, rather thick; aperture radiate.

There are at least two kinds of *Glandulina;* this one is derived from *Pyrulina,* and the other from *Marginulina.* Therefore it is almost impossible to give any synonymy without examining the actual specimens. D'Orbigny listed the present species from the Adriatic Sea, Tertiary of the environs of Siena, and Tertiary of the Vienna Basin. We have examined abundant specimens from the last two localities and found that d'Orbigny's *G. laevigata* is evidently related to *Pyrulina.* Such specimens figured by d'Orbigny in the Tableau and also in the Vienna Basin monograph have invariably an early stage consisting of biserial chambers.

GLANDULINA REUSSI Cushman and Ozawa, new species

Plate 40, figures 2 *a*, *b*

Psecadium acuminatum REUSS, Sitz. Akad. Wiss. Wien, vol. 62, pt. 1, 1870, p. 478.—v. SCHLICHT, Foram. Pietzpuhl, 1870, pl. 25, figs. 1–10.

Test elongate, fusiform to cylindrical, circular in section, greatest breadth near the apertural end, distinctly acute toward the initial end; chambers rounded, arranged in an entirely uniserial series; sutures not depressed, distinct; wall smooth, translucent; aperture often with an entosolenian tube, which is visible from the exterior, radiate.

Length of holotype 0.43 mm.; breadth 0.18 mm.

Holotype.—(Cushman Coll. No. 11884.) From the Oligocene of Pietzpuhl, Germany.

The present species is fairly well figured by v. Schlicht under the name of *Atractolina*, to which Reuss gave the name *Psecadium acuminatum*, but we include it in *Glandulina*. The name *acuminata* is preoccupied by d'Orbigny, and accordingly the new specific name *reussi* is proposed.

Distribution.—We have only a single specimen from the Oligocene of Pietzpuhl, Germany, the type locality.

GLANDULINA DIMORPHA (Bornemann)

Plate 40, figures 3–5

Guttulina dimorpha BORNEMANN, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 345, pl. 17, fig. 5.

Guttulina vitrea BORNEMANN, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 346, pl. 17, fig. 8.

Polymorphina proteiformis REUSS, Bull. Acad. Roy. Sci. Belg., ser. 2, vol. 15, 1863, p. 151, pl. 2, figs. 30–35 (not fig. 36; pl. 3, figs. 37–40).

Psecadium nussdorfensis KARRER, Abhandl. k. k. Geol. Reichs., vol. 9, 1877, p. 379, pl. 16 *b*, fig. 23.

Polymorphina vitrea BORNEMANN var. *glandulinoides* FORNASINI, Mem. Accad. Soc. Istit. Bologna, ser. 5, vol. 9, 1900–1902 (1902), p. 66, fig. 18 (in text).

Test fusiform (young microspheric form) to cylindrical (adult), acuminate (microspheric) or rounded (megalospheric) at the initial end; chambers inflated, arranged in a nearly triserial series in the young, becoming uniserial later in the microspheric form, or entirely uniserial, but not regularly so in the megalospheric form; sutures slightly depressed, generally distinct; wall smooth; aperture radiate.

Maximum length 1.20 mm.; diameter 0.44 mm.

The present species is undoubtedly derived from *Pyrulina fusiformis*. The early stage of the microspheric form of *Glandulina dimorpha* resembles *Pyrulina fusiformis*, yet its septa even in the young state tend to be placed at right angles to the exterior wall.

Guttulina vitrea (Bornemann) has the acute initial end and its septa becoming parallel to each other; however, it may represent the microspheric form of the present species.

Polymorphina glandulinoides Fornasini is undoubtedly a typical microspheric form.

The first figure of *Polymorphina proteiformis* Reuss, as well as *Psecadium nussdorfensis*, is characterized by the rounded initial end and almost parallel septa. They are considered to represent the megalospheric form of the present species.

Distribution.—We have specimens from the upper Oligocene of Ahnatal, near Cassel, Germany, and from the Miocene of Nussdorf in the Vienna Basin.

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EXPLANATION OF PLATES

Plate 1

Fig. 1. *Eoguttulina polygona* (Terquem). × 80. From Jurassic, Kimmeridge clay, Ely, England. *a*, *b*, side views; *c*, basal view.

2. *Eoguttulina liassica* (Strickland). × 80. From Jurassic, lower Lias, Chettenham, Gloucestershire, England. *a*, *b*, side views; *c*, basal view.

3. *Eoguttulina anglica* Cushman and Ozawa. × 45. From Cretaceous, Cambridge greensand, Saxon Cement Works, Cambridge, England. *a*, *b*, side views; *c*, basal view.

4. *Quadrulina rhabdogonioides* (Chapman). × 40. (After Chapman.) Cretaceous, lower Greensand, Bargate beds of Surrey, Littleton, England. *a*, side view; *b*, apertural view.

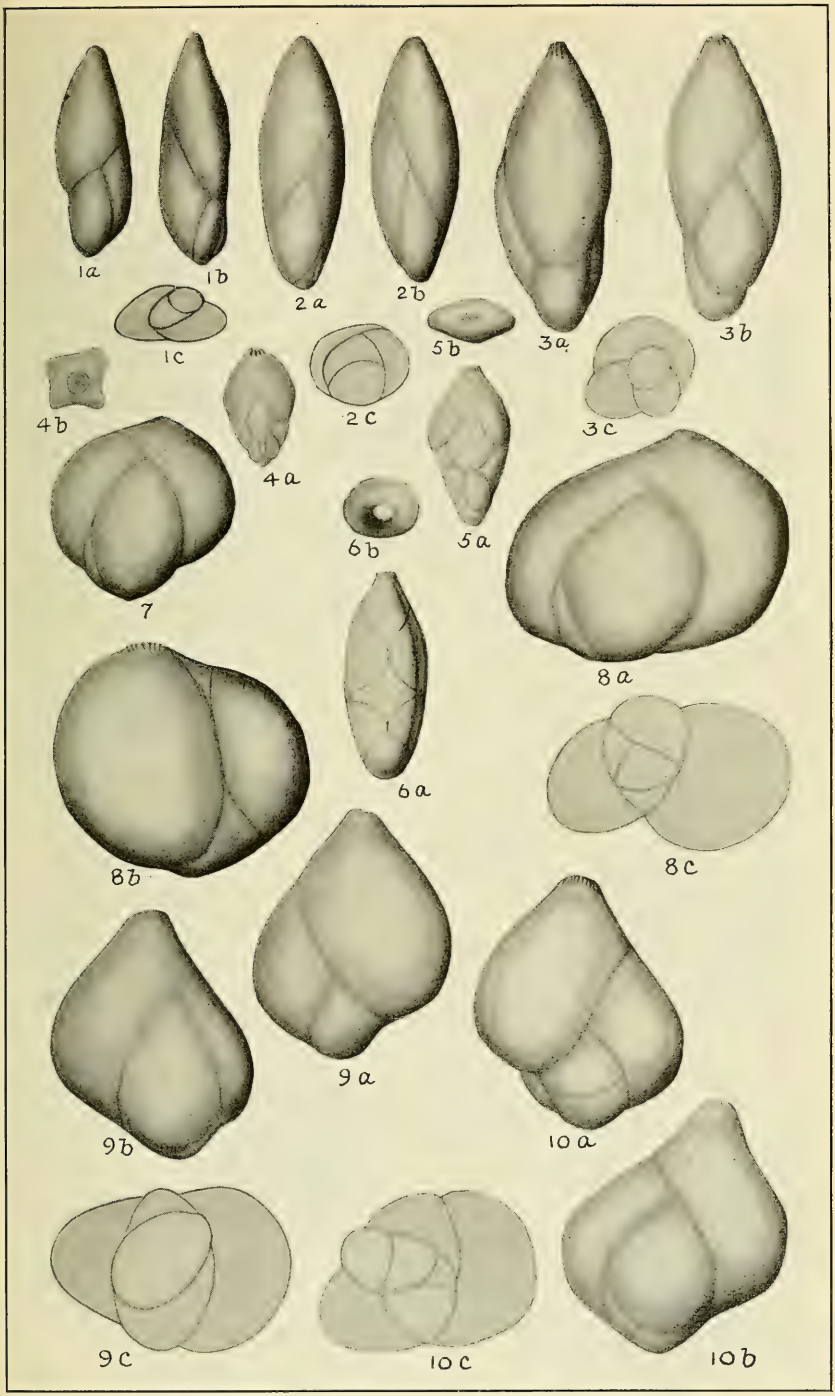
5. *Quadrulina frondicularioides* (Chapman). × 45. (After Chapman.) Cretaceous, lower Greensand, Bargate beds of Surrey, Littleton, England. *a*, side view; *b*, apertural view.

6. *Quadrulina lagenalis* (Terquem). (After Terquem.) Lower Lias, Quenleu-les-Metz, France. *a*, side view; *b*, apertural view.

7, 8. *Guttulina bulloides* (Reuss). × 30. From Miocene of Pontlevoy, France. 7, Young specimen. 8 *a*, *b*, side views; 8 *c* basal view.

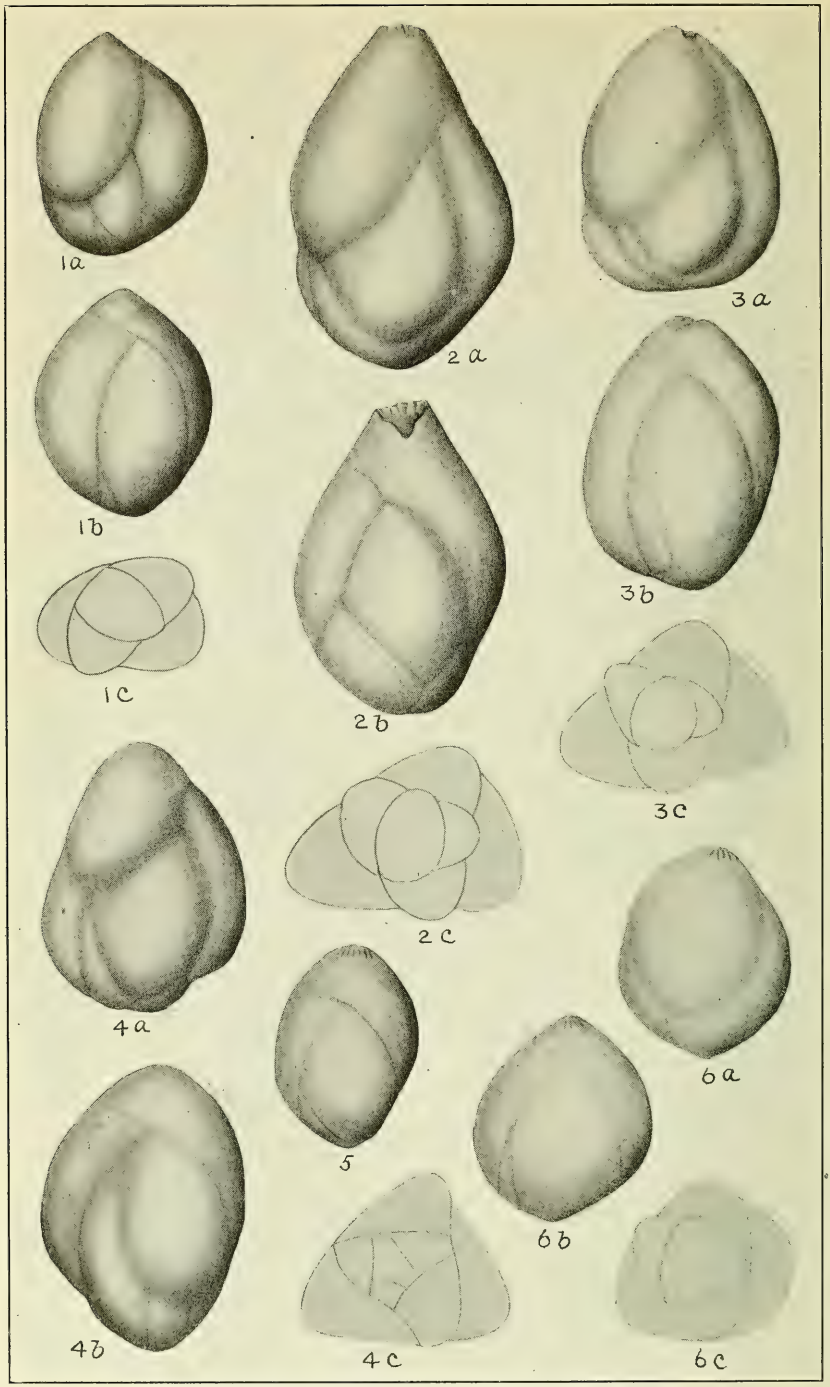
9. *Guttulina adhaerens* (Olszewski). × 40. From Cretaceous, Chalkmarl, Saxon Cement Works, Cambridge, England. *a*. *b*, side views; *c*, basal view.

10. *Guttulina bartschi* Cushman and Ozawa. × 45. From *Albatross* D5178, 78 fathoms off Romblon, Philippines. *a*, *b*, side views; *c*, basal view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 146.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 147

Plate 2

All figures *Guttulina problema* d'Orbigny

Figs. 1, 2. From Pliocene, Castel Arquato, Italy. × 45. *a*, *b*, side views; *c*, basal view.

3, 4. From Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. × 35. *a*, *b*, side views; *c*, basal view.

5. From Upper Oligocene, Ahnatal, near Cassel, Germany. × 45.

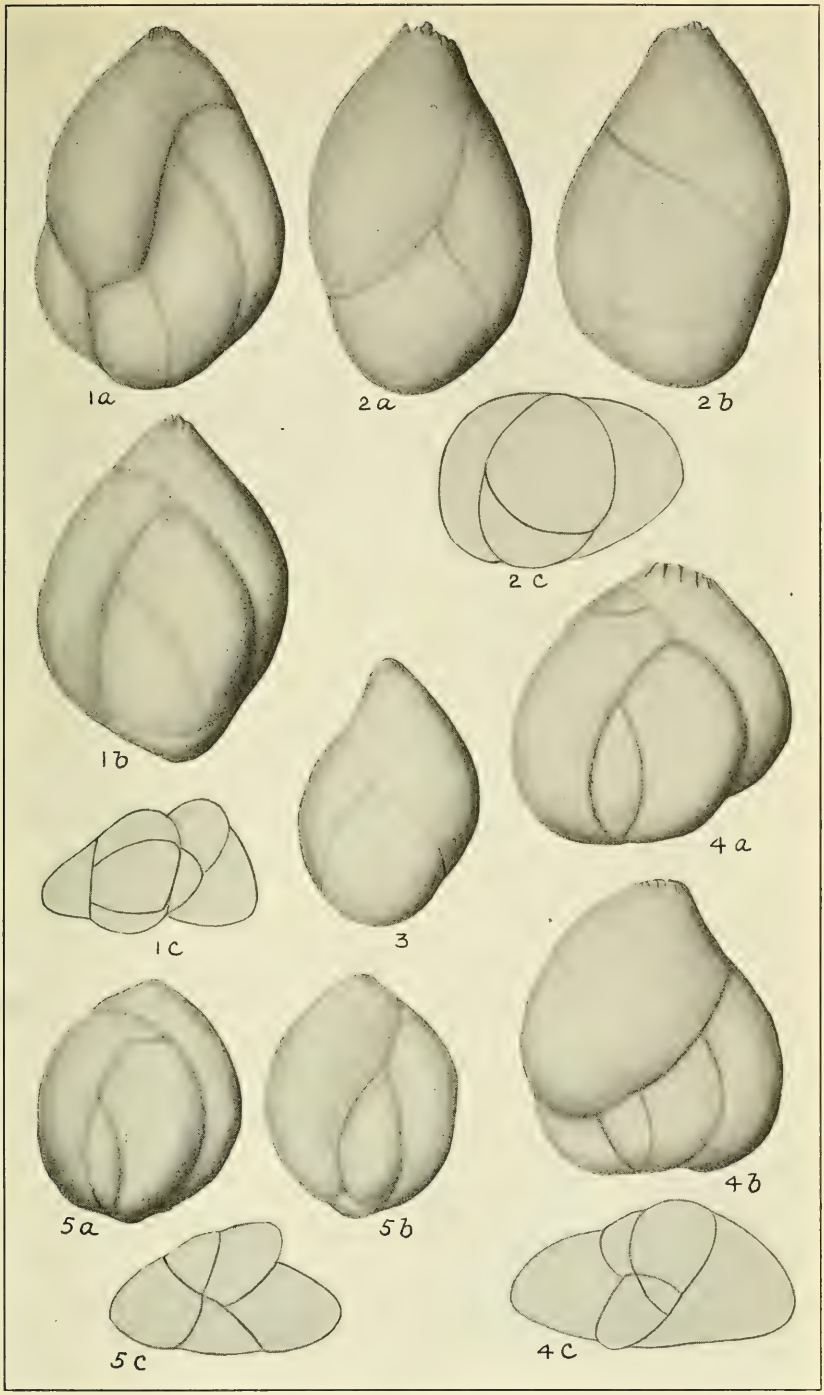
6. From Cretaceous, Flysch, Austria. × 35. *a*, *b*, side views; *c*, basal view.

Plate 3

Figs. 1. *Guttulina problema* d'Orbigny. × 45. Pliocene, Stazzano, Italy. *a*, *b*, side views; *c*, basal view.

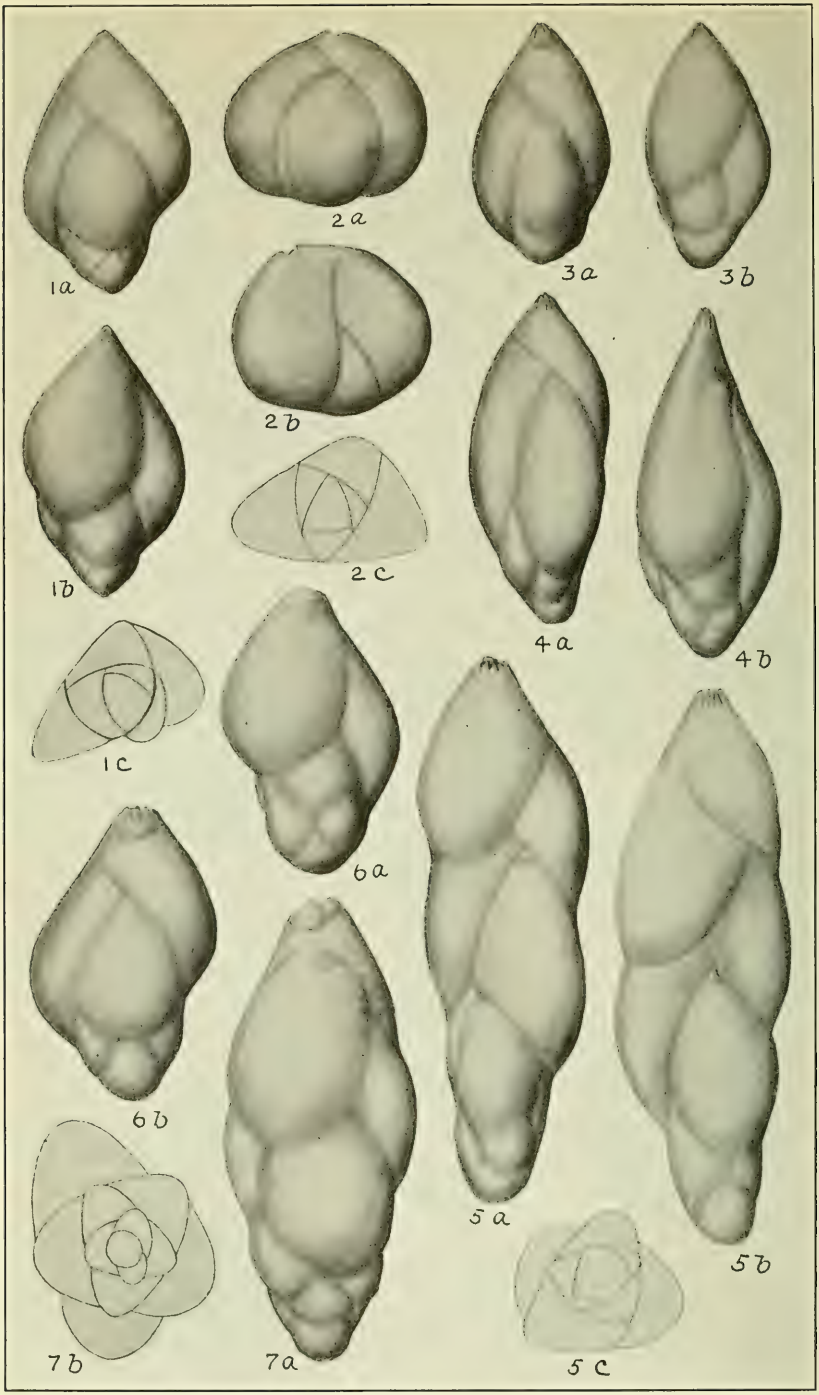
2, 3. *Guttulina orientalis* Cushman and Ozawa. × 35. Pliocene, Sawane, Island of Sado, Japan. *a*, *b*, side views; *c*, basal view.

4, 5. *Guttulina irregularis* (d'Orbigny). Miocene, Tortonian, *Amphistegina* marl, Nussdorf, near Vienna, Austria. *a*, *b*, side views; *c*, basal view. 4, adult. × 25. 5, young. × 35.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 148.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 149.

PLATE 4

FIG. 1. *Guttulina frankei* Cushman and Ozawa. × 45. Middle Oligocene, Söllingen, Germany. *a*, *b*, side views; *c*, basal view.

2. *Guttulina trigonula* (Reuss). × 80. Cretaceous, Lower Gault, Cambridge Brickyard, Cambridge, England. *a*, *b*, side views; *c*, basal view.

3–5. *Guttulina austriaca* d'Orbigny. × 45. Miocene, brickyard of Baden, near Vienna, Austria. 3, 4, early stages. 5, adult. *a*, *b*, side views; *c*, basal view.

6, 7. *Guttulina yabei* Cushman and Ozawa. × 35. Pliocene, Sawané, Island of Sado, Japan. 6 *a*, *b*, side views of young specimen. 7, adult, *a*, side view; *b*, basal view.

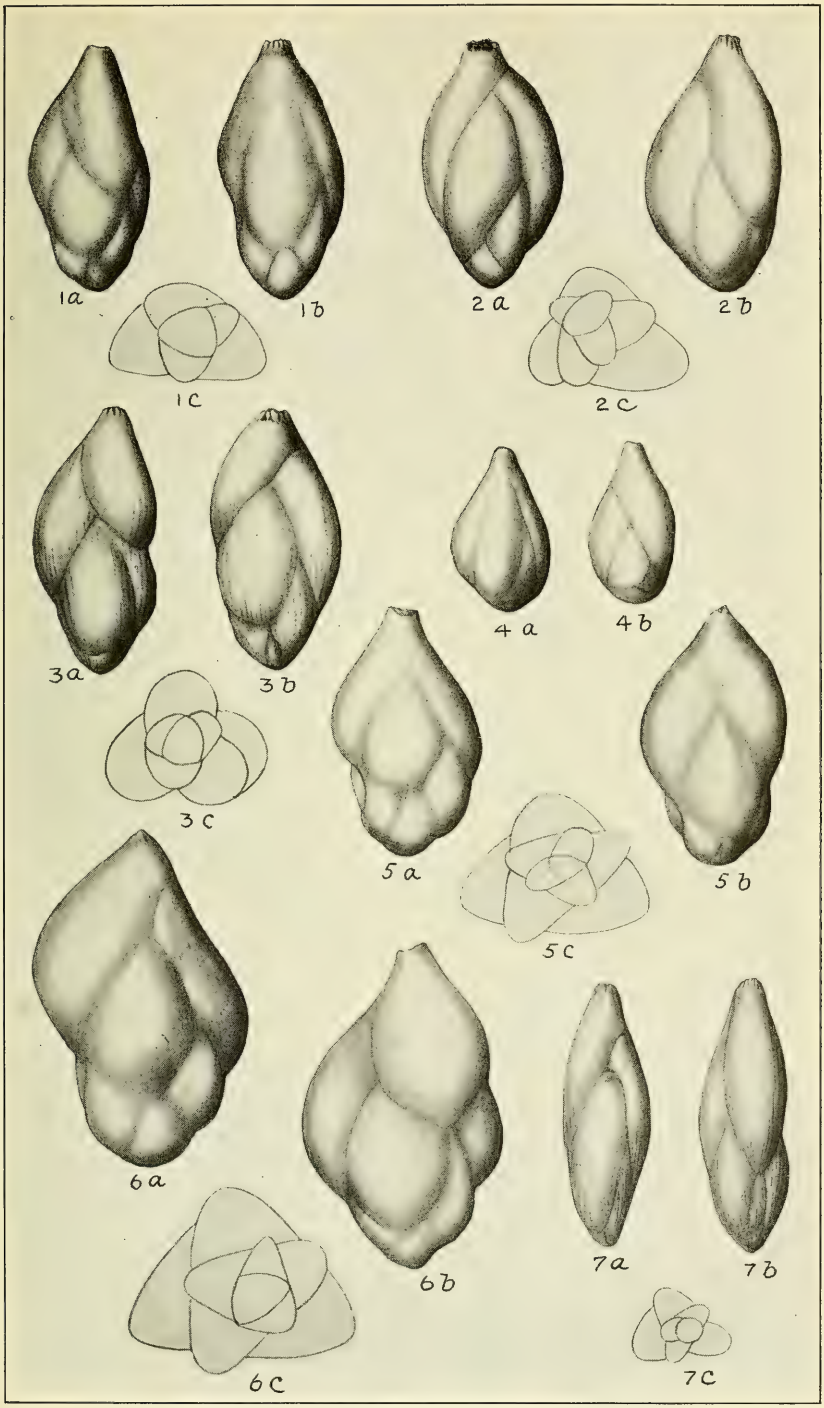
Plate 5

Figs. 1, 2. *Guttulina spicaeformis* (Roemer). × 45. Oligocene, Düsseldorf, Germany. *a*, *b*, side views; *c*, basal view.

3. *Guttulina spicaeformis* (Roemer) var. *australis* (d'Orbigny). × 45. Recent, off Loggerhead Key, Dry Tortugas, Fla., 18 fathoms. *a*, *b*, side views; *c*, basal view.

4–6. *Guttulina hantkeni* Cushman and Ozawa. × 35. Eocene, New Jersey. 4 *a*, early stage; *b*, adult. 6, holotype. Kleinzeller near Ofen, Hungary. Adult.

7. *Guttulina pulchella* d'Orbigny. × 45. Recent, off Loggerhead Key, Dry Tortugas, Fla., 18 fathoms. *a*, *b*, side views; *c*, basal view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

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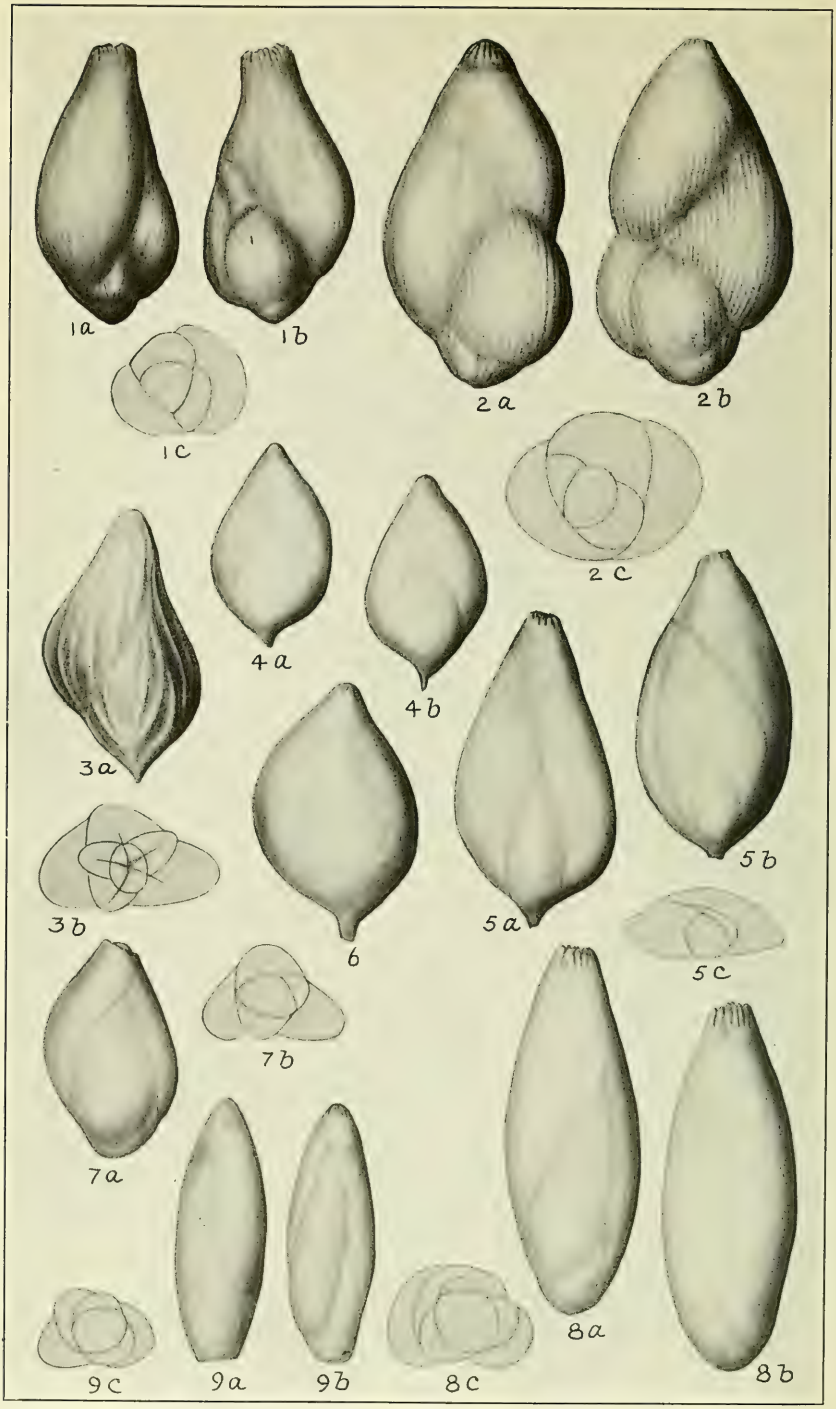


FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 151.

Plate 6

Figs. 1, 2. *Guttulina regina* (H. B. Brady, Parker, and Jones). × 45. 1, young specimen from Newcastle Beach, New South Wales. 2, adult from off Tawi Tawi Group, Philippines, 34 fathoms. *a*, *b*, side views; *c*, basal view.

3. *Guttulina costatula* Galloway and Wissler. × 65. Pleistocene, Lomita Quarry, Palos Verdes Hills, California. *a*, side view; *b*, basal view.

4, 5. *Guttulina caudata* d'Orbigny. × 80. 4, young specimen, Eocene, Lutetien moyen, Grignon, France. 5, older specimen, Eocene, Lutetien, Vaudancourt, France. *a*, *b*, side views; *c*, basal view.

6. *Guttulina adhaerens* (Olszewski) var. *cuspidata* Cushman and Ozawa, n. var. × 45. Cretaceous, chalk marl, Folkestone, England.

7. *Guttulina adhaerens* (Olszewski). × 45. Cretaceous, chalk marl, Folkestone, England. *a*, side view; *b*, basal view.

8. *Guttulina praelonga* (Egger). × 35. Upper Oligocene, Ahnatal, near Cassel, Germany.

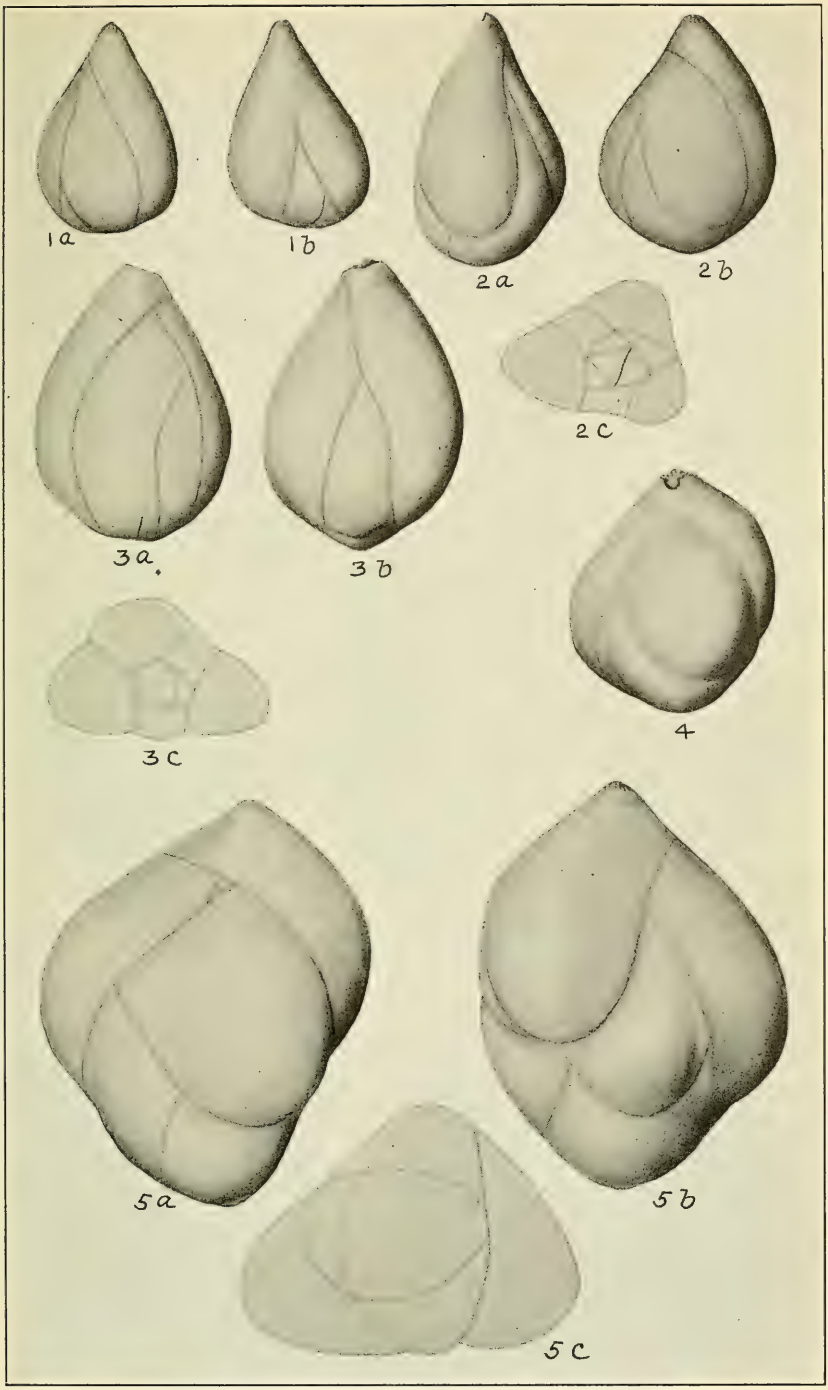
9. *Guttulina guttiformis* (Terquem). × 45. Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. *a*, *b*, side views; *c*, basal view.

Plate 7

Figs. 1, 2. *Guttulina irregularis* (d'Orbigny). × 45. Early stages, middle Oligocene, Hermsdorf, near Berlin, Germany. *a*, *b*, side views; *c*, basal view.

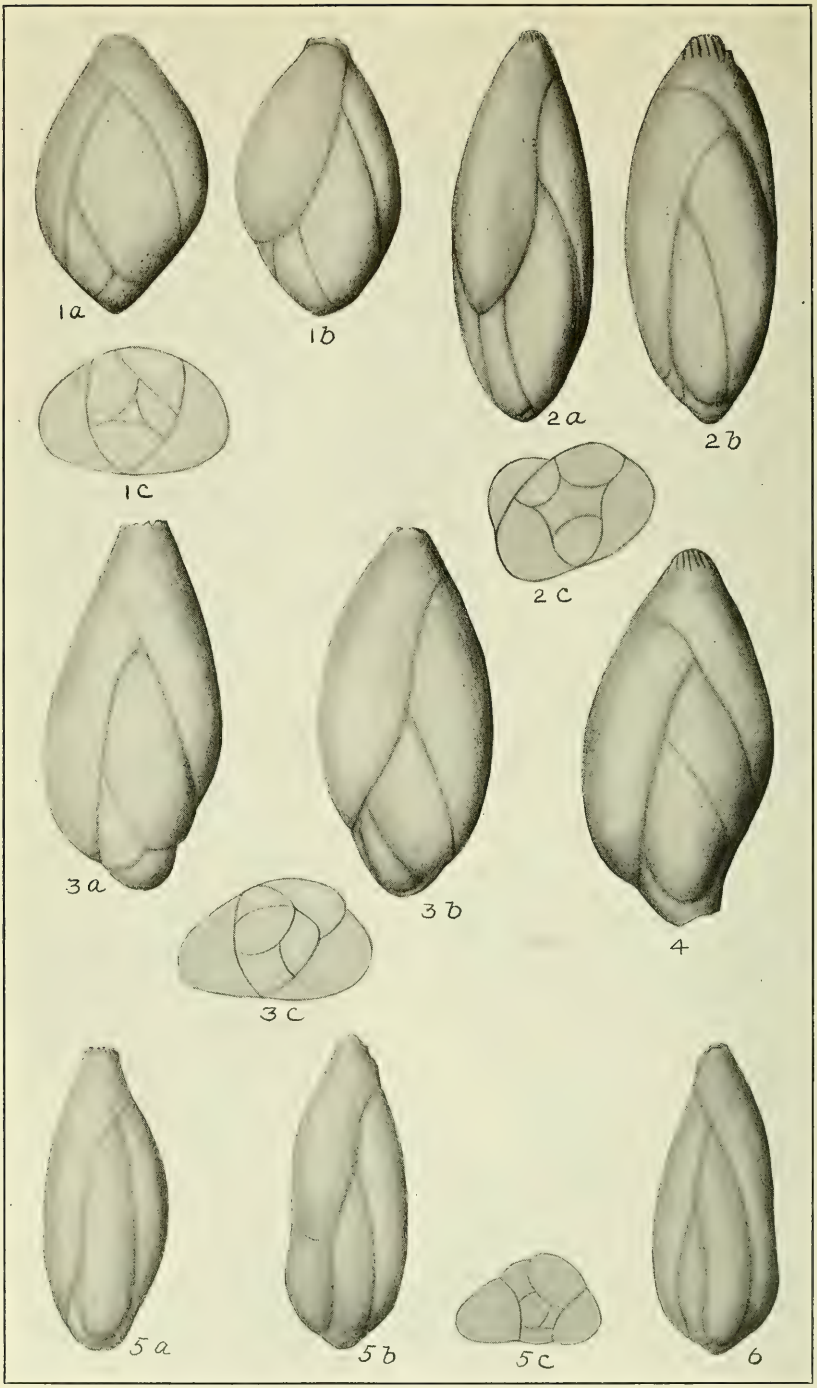
3. *Guttulina irregularis* d'Orbigny var. *nipponensis* Cushman and Ozawa, n. var. × 45. Upper Pliocene, Okuwa, Province of Kaga, Japan. *a*, *b*, side views; *c*, basal view.

4, 5. *Guttulina jarvisi* Cushman and Ozawa. × 30. Eocene, Cipero section, Trinidad, British West Indies. 4, young. 5, adult. *a*, *b*, side views; *c*, basal view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 152.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 153.

Plate 8

Figs. 1, 2. *Guttulina lehneri* Cushman and Ozawa. × 35. Eocene, San Fernando, Trinidad, British West Indies. 1, young, 2, adult. Holotype.

3, 4. *Guttulina yamazakii* Cushman and Ozawa. × 35. 3, upper Pliocene, Natsukawa, Province of Echigo, Japan. 4, holotype, from *Albatros* D4807, off Japan. *a*, *b*, side views; *c*, basal view.

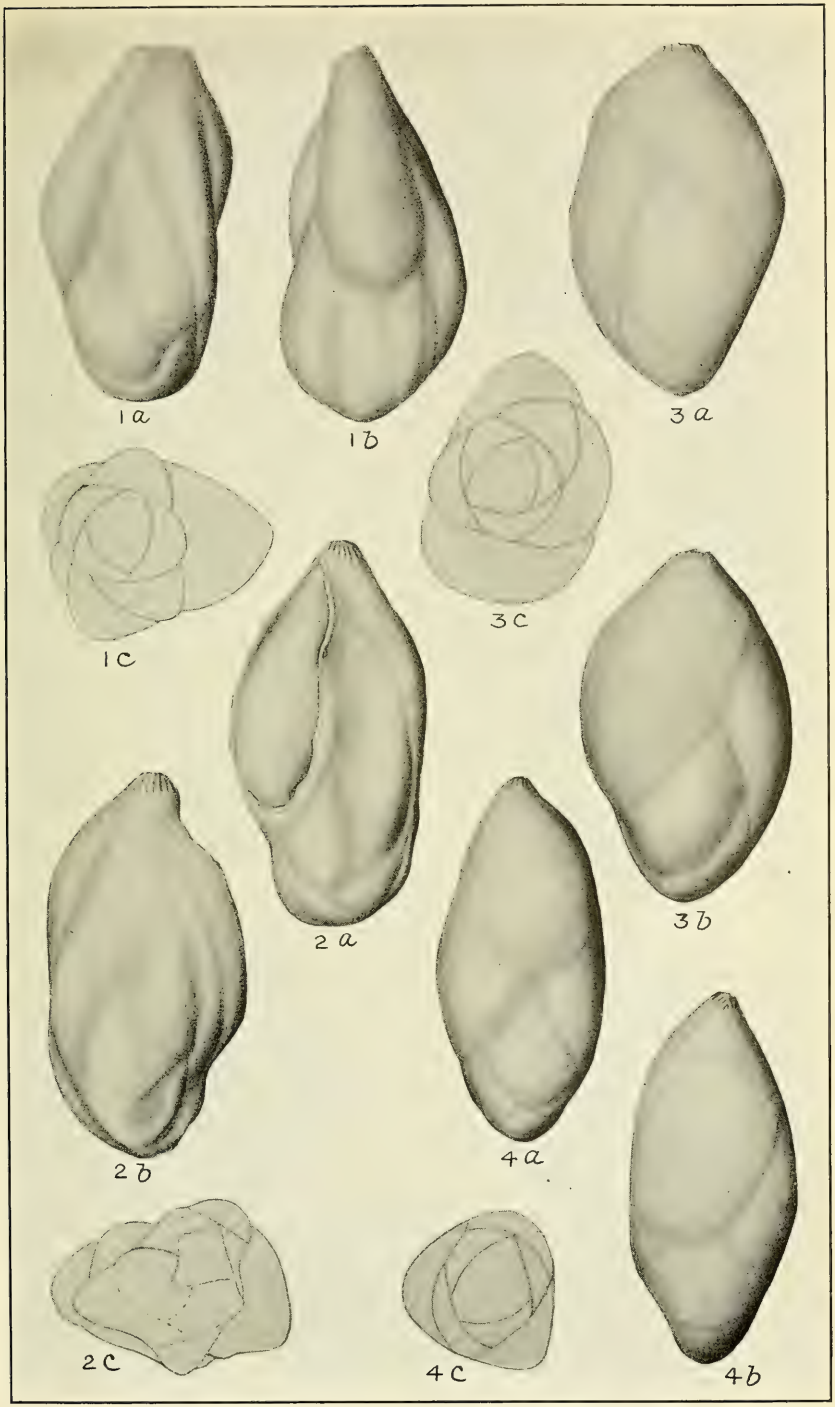
5, 6. *Guttulina kishinouyi* Cushman and Ozawa. × 40. Upper Pliocene, Natsukawa, Province of Echigo, Japan. 5, holotype. 6, paratype. *a*, *b*, side views; *c*, basal view.

Plate 9

Figs. 1, 2. *Guttulina baileyi* Cushman and Ozawa. × 30. 1, Holotype, *Albatross* D2416, coast of Carolina, 276 fathoms. 2, *Albatross* D5151, off Tawi Tawi Group, Philippines, 24 fathoms. *a*, *b*, side views; *c*, basal view.

3. *Guttulina roemeri* (Reuss). × 45. Upper Oligocene, Ahnatal, near Cassel, Germany. *a*, *b*, side views; *c*, basal view.

4. *Guttulina roemeri* (Reuss) var. *gigas* (Karrer). × 60. Miocene, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna, Austria. *a*, *b*, side views; *c*, basal view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

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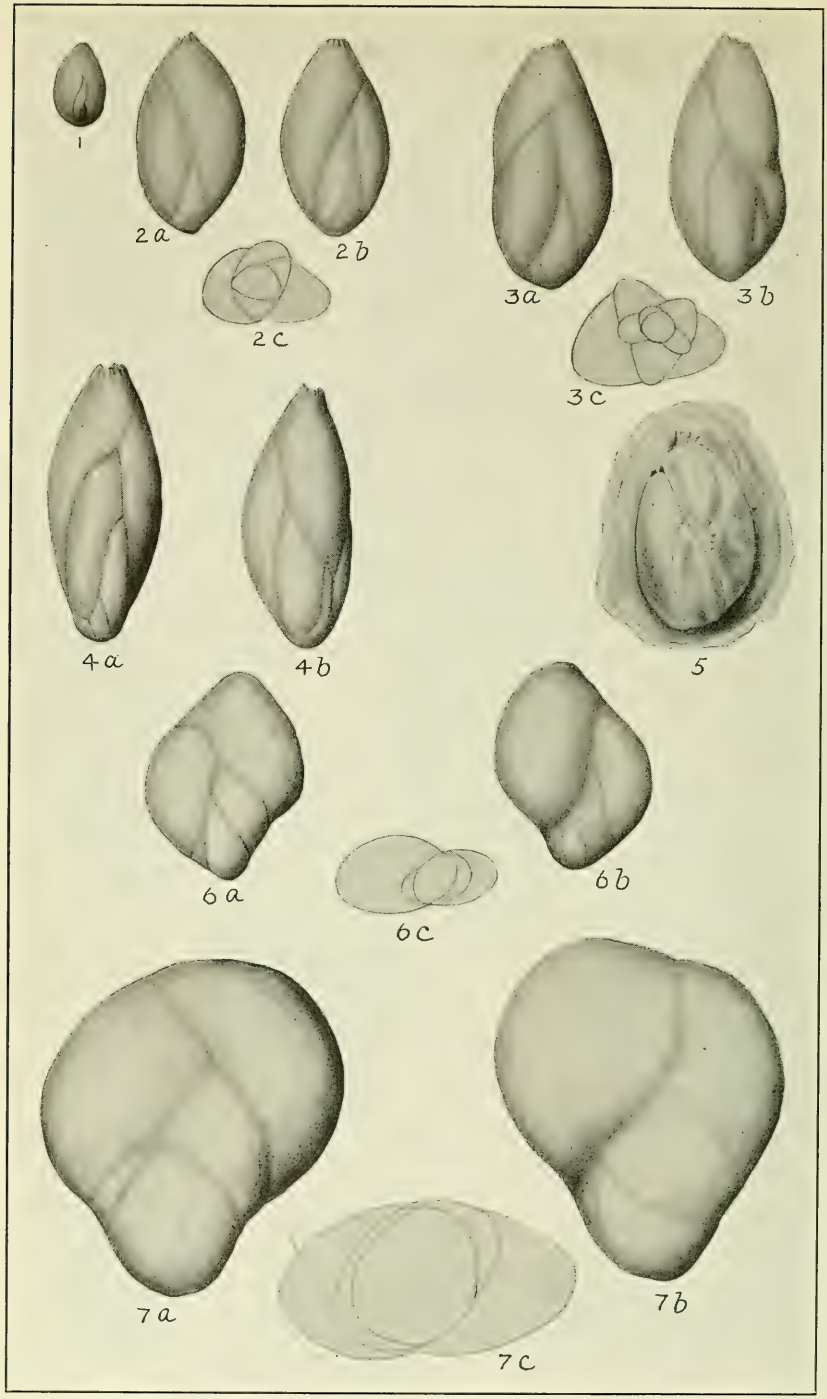


FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 155.

Plate 10

Figs. 1–4. *Guttulina lactea* (Walker and Jacob). 1, copied from Walker and Jacob's original figure. 2–4, from off Bantry Bay, southwest Ireland, 37½ fathoms. *a*, *b*, side views; *c*, basal view.

5. *Guttulina lactea* (Walker and Jacob) var. *earlandi* Cushman and Ozawa, n. var. × 65. Selsey Bill, England (After Heron-Allen and Earland).

6, 7. *Pseudopolymorphina variata* (Jones, Parker, and H. B. Brady) var. *fischeri* (Terquem). 6, adult. Pliocene, Crag, Sutton, England. × 30. 7, young. *a*, *b*, side views; *c*, basal view. × 45. Miocene, Burdigalien inferieur, Moulin de l'Eglise, Saucats, France.

Plate 11

Fig. 1. *Guttulina schafferi* Cushman and Ozawa. × 45. Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna, Austria. *a*, *b*, side views; *c*, basal view.

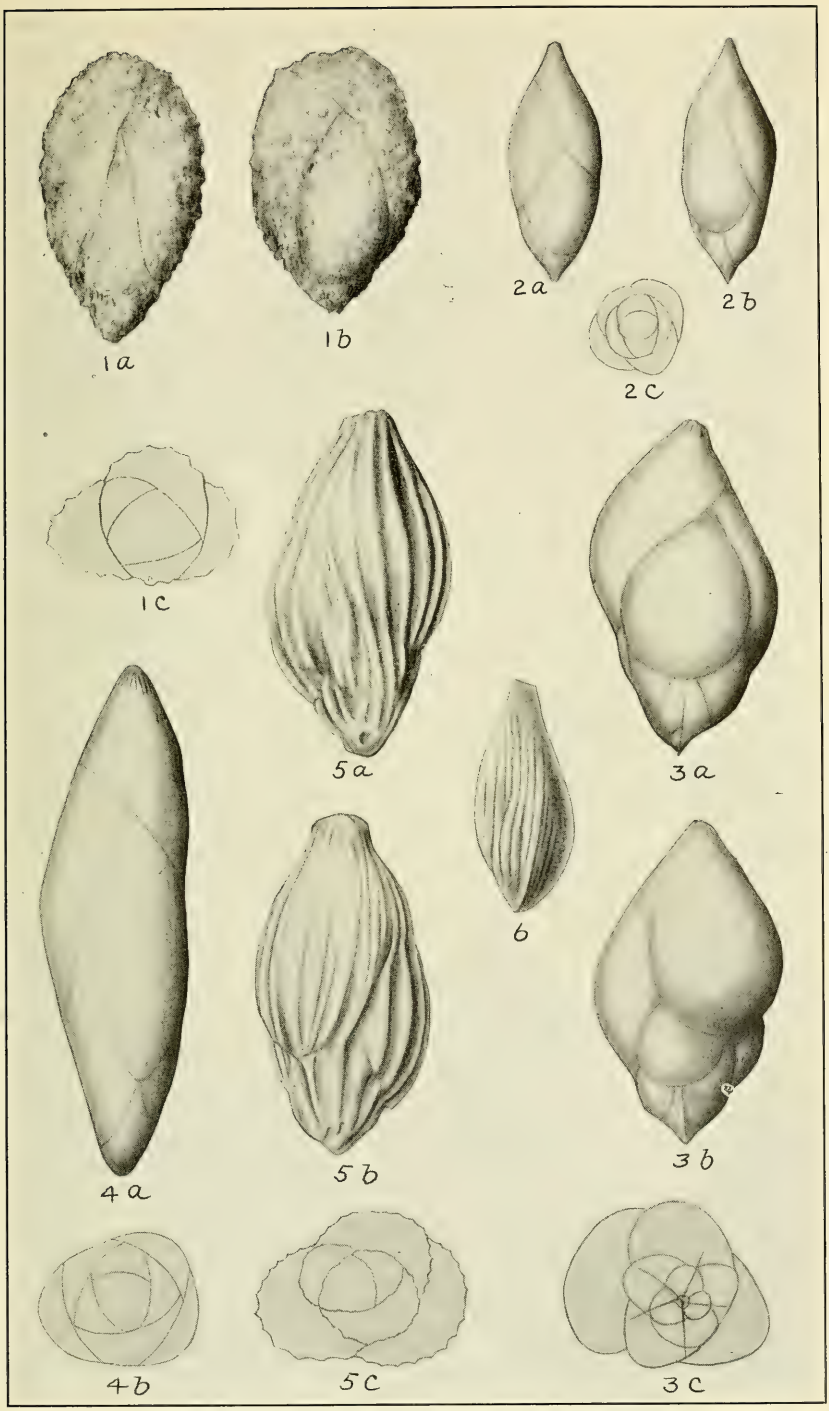
2. *Guttulina woodsi* Cushman and Ozawa. × 80. Cretaceous, lower Gault, Barnwell pit, Cambridge, England.

3. *Guttulina quinquecosta* Cushman and Ozawa. × 45. Pliocene, Timms Point, San Pedro, Calif. *a*, *b*, side views; *c*, basal view.

4. *Guttulina paalzowi* Cushman and Ozawa. × 35. Cretaceous, Maastricht, Holland. *a*, side view; *b*, basal view.

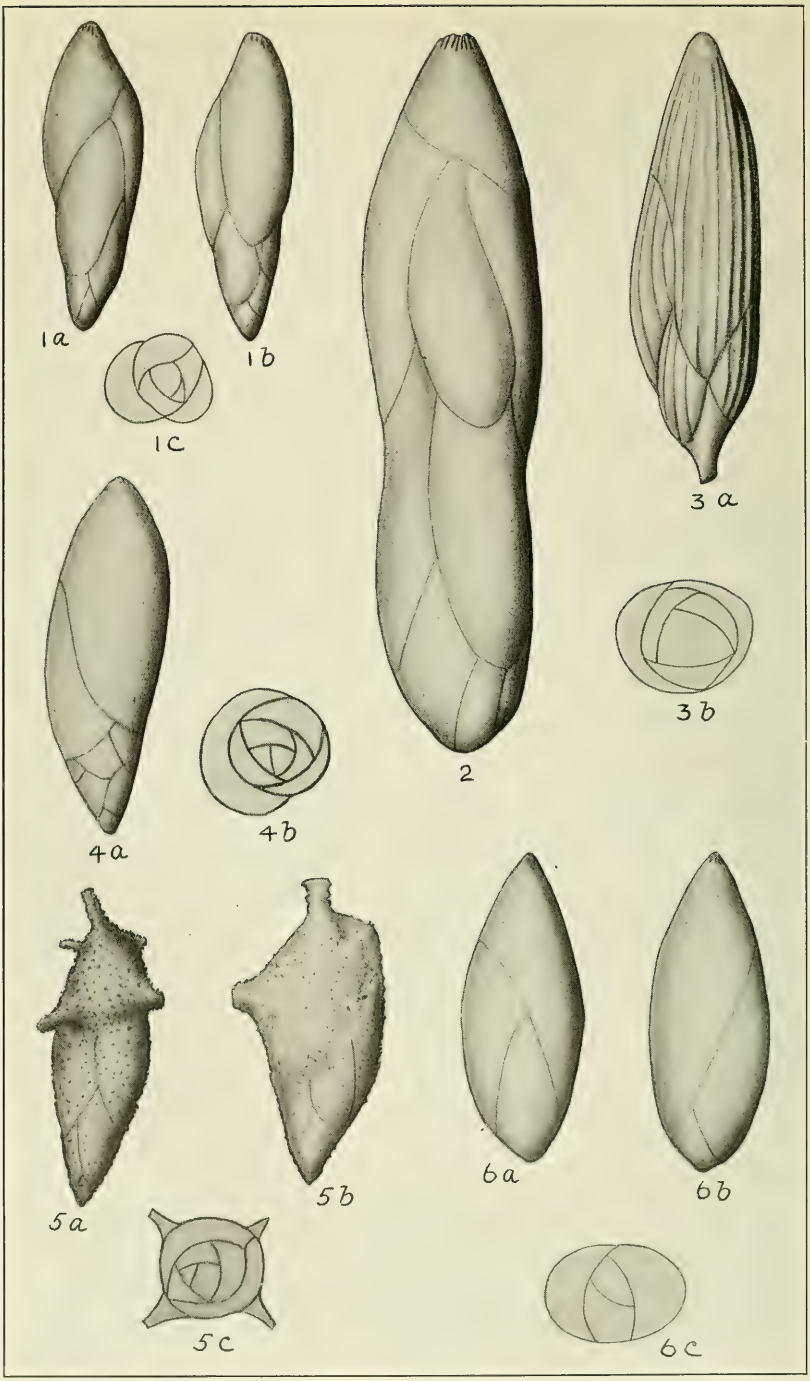
5. *Guttulina regina* (H. B. Brady, Parker, and Jones) var. *crassicostata* Cushman and Ozawa. × 45. Lower Pliocene, Beaumaris, near Melbourne, Victoria, Australia. *a*, *b*, side views; *c*, basal view.

6. *Guttulina emersoni* (Bagg). × 25. (After Bagg.)



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 156.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 157.

Plate 12

Figs. 1, 2. *Guttulina dawsoni* Cushman and Ozawa. × 35. Gaspé Bay. 1, holotype. 2, abnormally large specimen occurring with the typical form. *a*, *b*, side views; *c*, basal view.

3. *Guttulina costulata* (Cushman). × 80. Lower Oligocene, Mint Spring marl, Mint Spring Bayou, Vicksburg, Miss. *a*, side view; *b*, basal view.

4. *Pyrulina labiata* (Schwager). × 45. Pliocene, Fiji. *a*, side view; *b*, basal view.

5. *Pyrulina extensa* (Cushman). × 45. Pacific. *a*, *Nero* 1063, 1,884 fathoms. *b*, *Nero* 2061, 1,670 fathoms. *a*, *b*, side views; *c*, basal view.

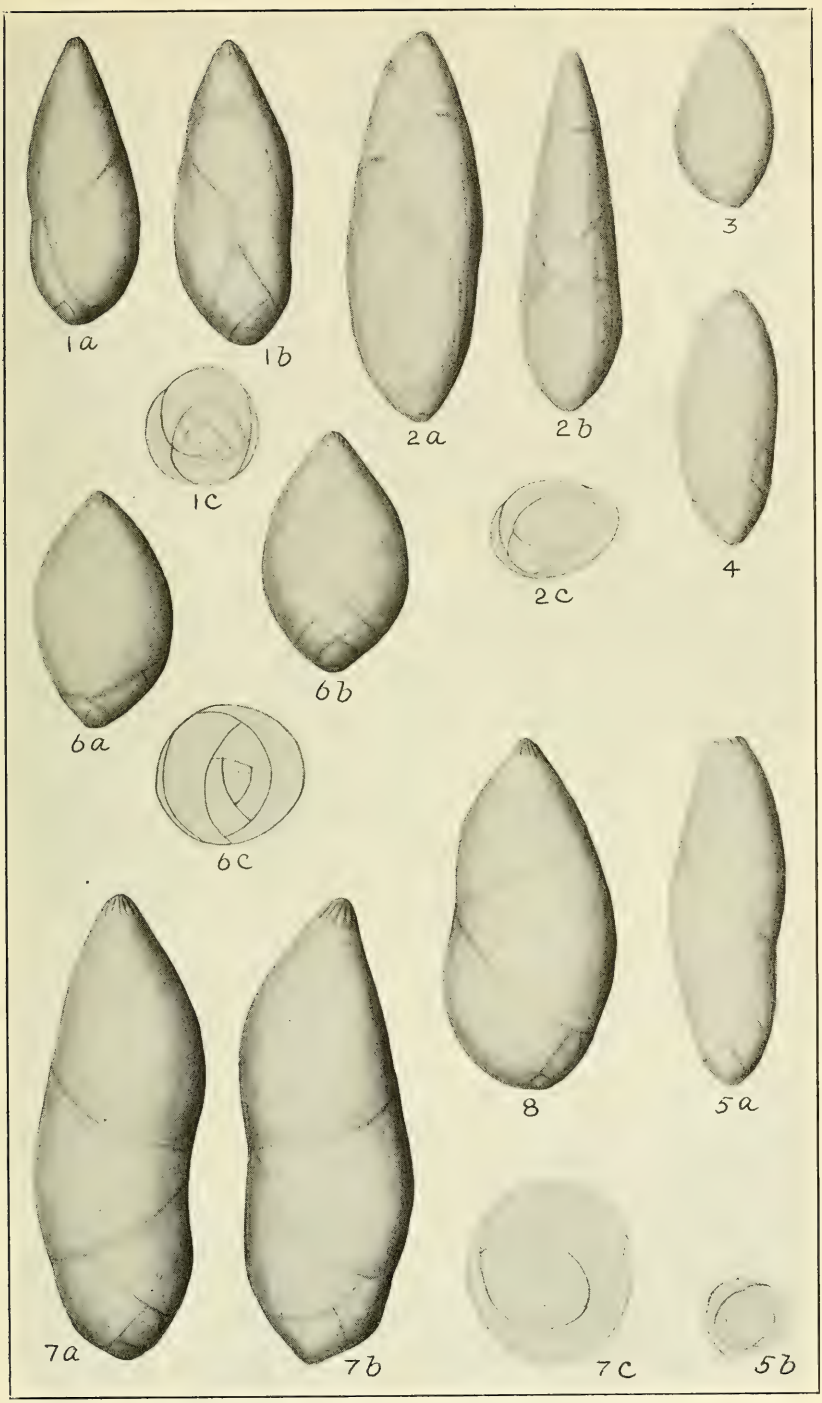
6. *Globulina prisca* Reuss. × 65. Cretaceous, Cambridge greensand, Saxon Cement Works, Cambridge, England. *a*, *b*, side views; c, basal view.

PLATE 13

FIG. 1. *Pyrulina gutta* d'Orbigny. × 45. Lowest Eocene, Wansin, Belgium. *a*, *b*, side views; *c*, basal view.

2. *Pyrulina vicksburgensis* (Cushman). × 80. Lower Oligocene, Mint Spring marl, at waterfall in Mint Spring Bayou, Vicksburg, Miss. *a*, *b*, side views; *c*, basal view.

3–8. *Pyrulina fusiformis* (Roemer). × 45. Upper Oligocene. 3–5, Ahnatal, near Cassel, Germany. 3, 4, early stages. 5, adult. 6, young. Cretaceous, chalk marl, Saxon Cement Works, Cambridge, England. 7, 8, Miocene. Tortonian, brickyard at Baden, near Vienna, Austria.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

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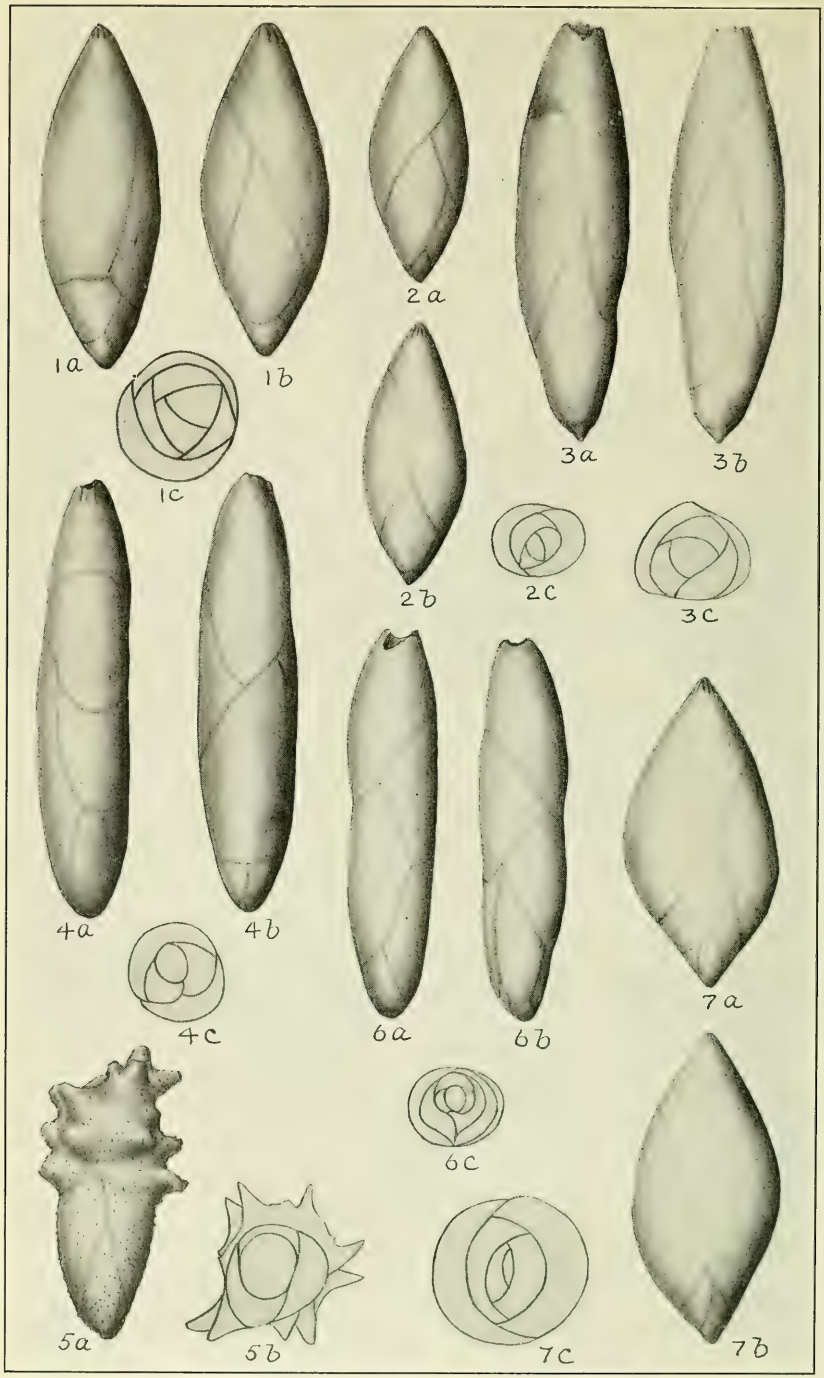


FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 159.

Plate 14

Figs. 1–5. *Pyrulina cylindroides* (Roemer). 1, × 45. Middle Oligocene, Hermsdorf, near Berlin, Germany. 2, × 80. Cretaceous, lower Gault, Barnwell pit, Cambridge, England. 3, × 45. Upper Oligocene, Ahnatal, near Cassel, Germany. 4, × 45. *a*, Cretaceous, upper Senonian, Dasbeck; *b*, Hanover, Westphalia, Germany. 5, × 45. Fistulose form, Cretaceous, Cambridge greensand, Saxon Cement Works, Cambridge, England.

6. *Pyrulina thouini* (d'Orbigny). × 45. Eocene, Lutetien moyen, Grignon, France. *a*, *b*, side views; *c*, basal view.

7. *Pyrulina acuminata* d'Orbigny. × 45. Cretaceous, Craie blanc, Bougival, France. *a*, *b*, side views; *c*, basal view.

Plate 15

Figs. 1–3. *Pyrulina albatrossi* Cushman and Ozawa. 1, × 25. *Albatross* D2160, 167 fathoms, off Cuba. 2, 3, × 65. *Albatross* D2756, 417 fathoms, off Brazil. 3, with an extra chamber.

4. *Pyrulina reticulosa* Cushman and Ozawa. × 45. Off Japan, *Albatross* D4882, 248 fathoms. *a*, side view; *b*, basal view.

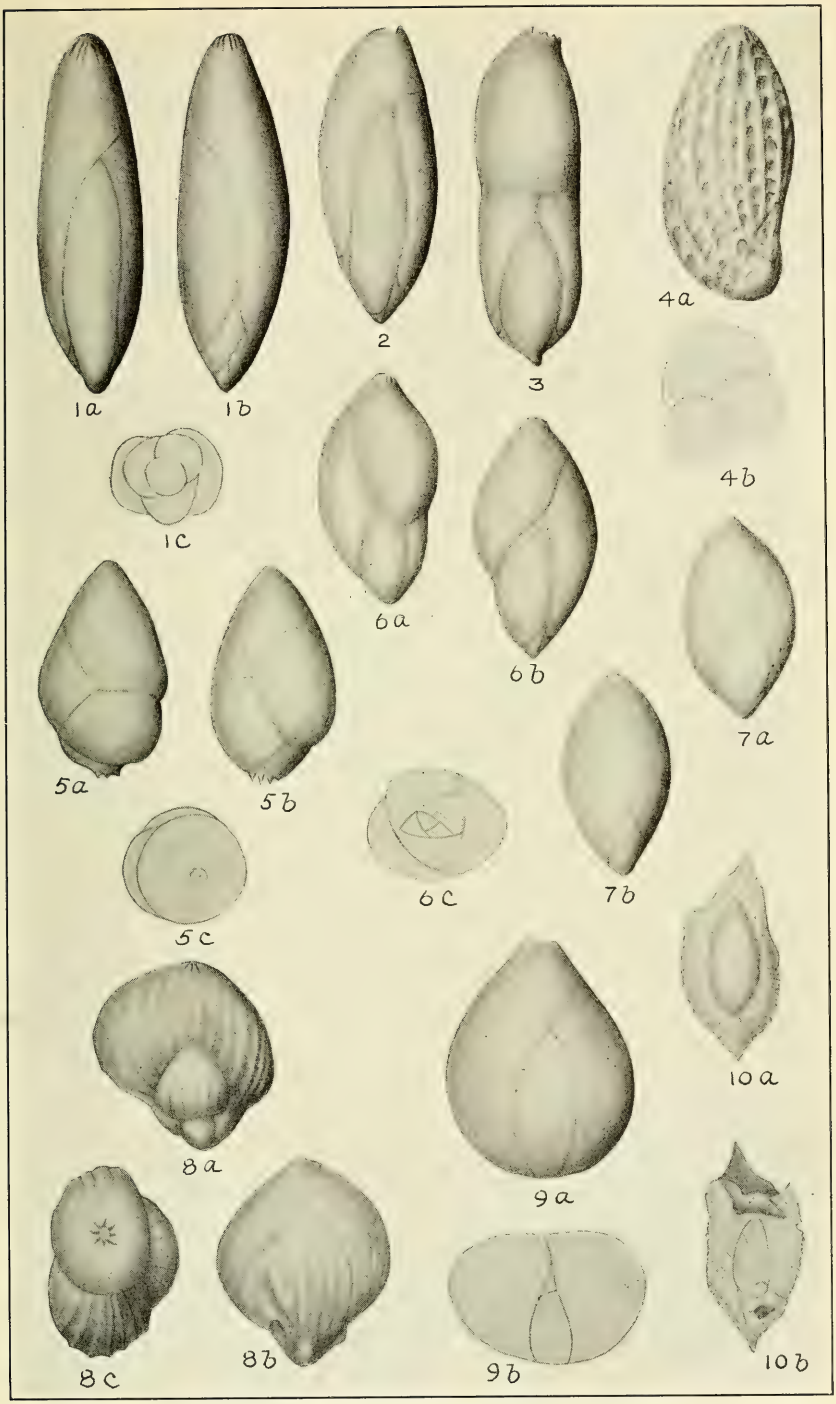
5. *Globulina rotundata* (Bornemann) var. *pyrula* (Fornasini). × 35. (After type figure.) Pliocene, Siena, Italy.

6, 7. *Globulina glacialis* Cushman and Ozawa. × 65. Pleistocene, glacial clay, north side of the glen, near Montreal, Canada. 6, holotype, with an extra chamber. *a*, *b*, side views; *c*, basal view.

8. *Guttulina semicostata* (Marsson). × 30. (After Marsson.) *a*, *b*, side views; *c*, apertural view.

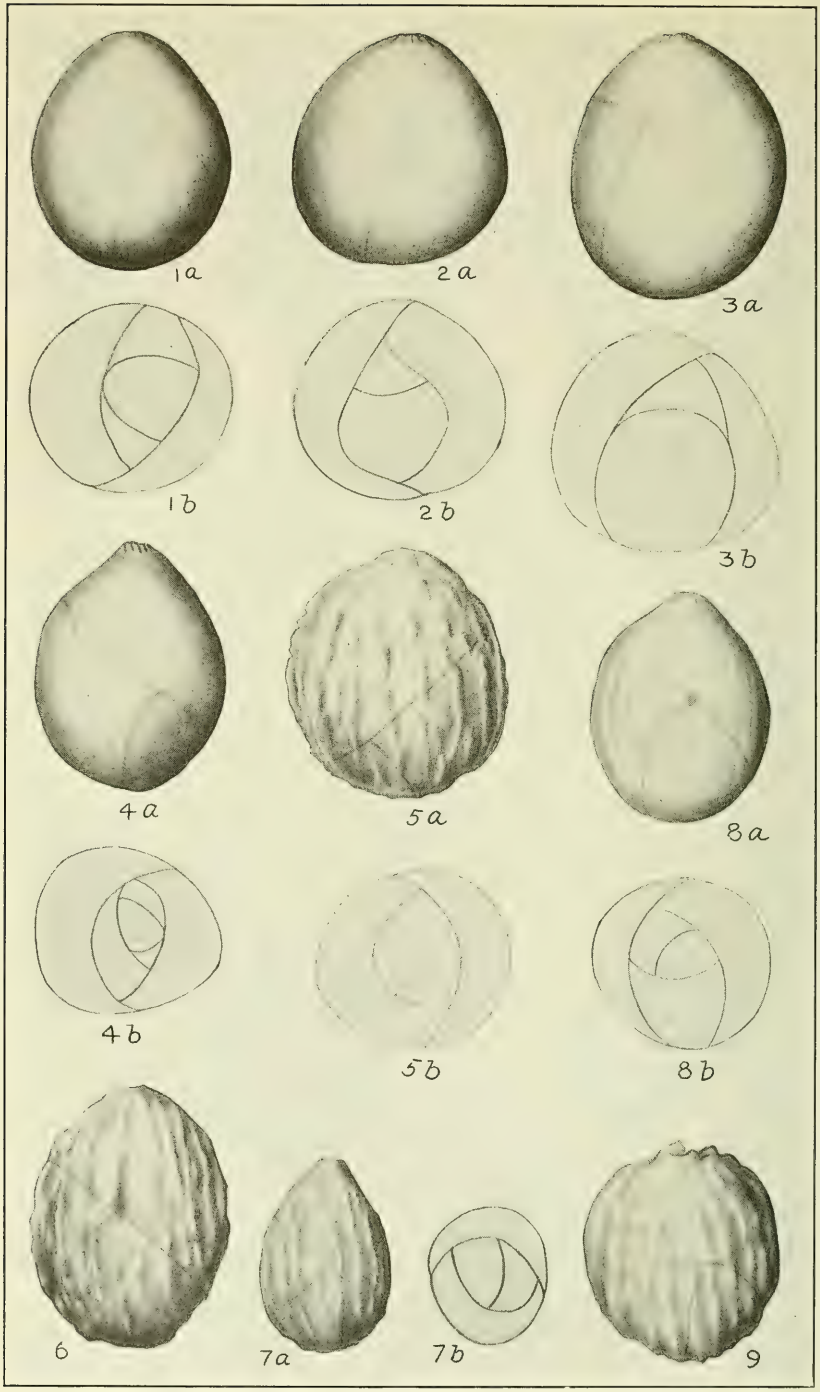
9. *Globulina landesi* (G. D. Hanna and M. A. Hanna). × 65. Recent, off Kobama, Province of Echizen, Japan. *a*, side view; *b*, basal view.

10. *Globulina dentimarginata* (Chapman). × 40. (After Chapman.) *a*, outer surface; *b*, attached side.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 160.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 161.

Plate 16

Figs. 1–4. *Globulina gibba* d'Orbigny. 1, × 35. Miocene, St. Paul de Dax, near Bordeaux, France. 2, × 45. Miocene, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna, Austria. 3, × 65. Eocene, Lutetien, Grignon, France. 4, × 35. Miocene, Perchtoldsdorf, near Vienna, Austria.

5–7. *Globulina gibba* d'Orbigny var. *striata* Egger. × 80. 5, Drawn from Egger's paratype, from Miocene, near Ortenburg, Germany. 6, Miocene, Tortonian, Varpolata, Hungary. 7, Miocene, near Ortenburg, Germany.

8. *Globulina gibba* d'Orbigny var. *myristiformis* (Williamson). × 65. From *Lord Bandon* dredgings, off southwest Ireland. *a*, side view; *b*, basal view.

9. *Globulina gibba* d'Orbigny var. *ornata* (Karrer). × 45. Miocene, Kostej, Banat, Hungary.

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Plate 17

Fig. 1. *Globulina inaequalis* Reuss var. *spinata* Cushman and Ozawa, × 80. Upper Oligocene, Ahnatal, near Cassel, Germany.

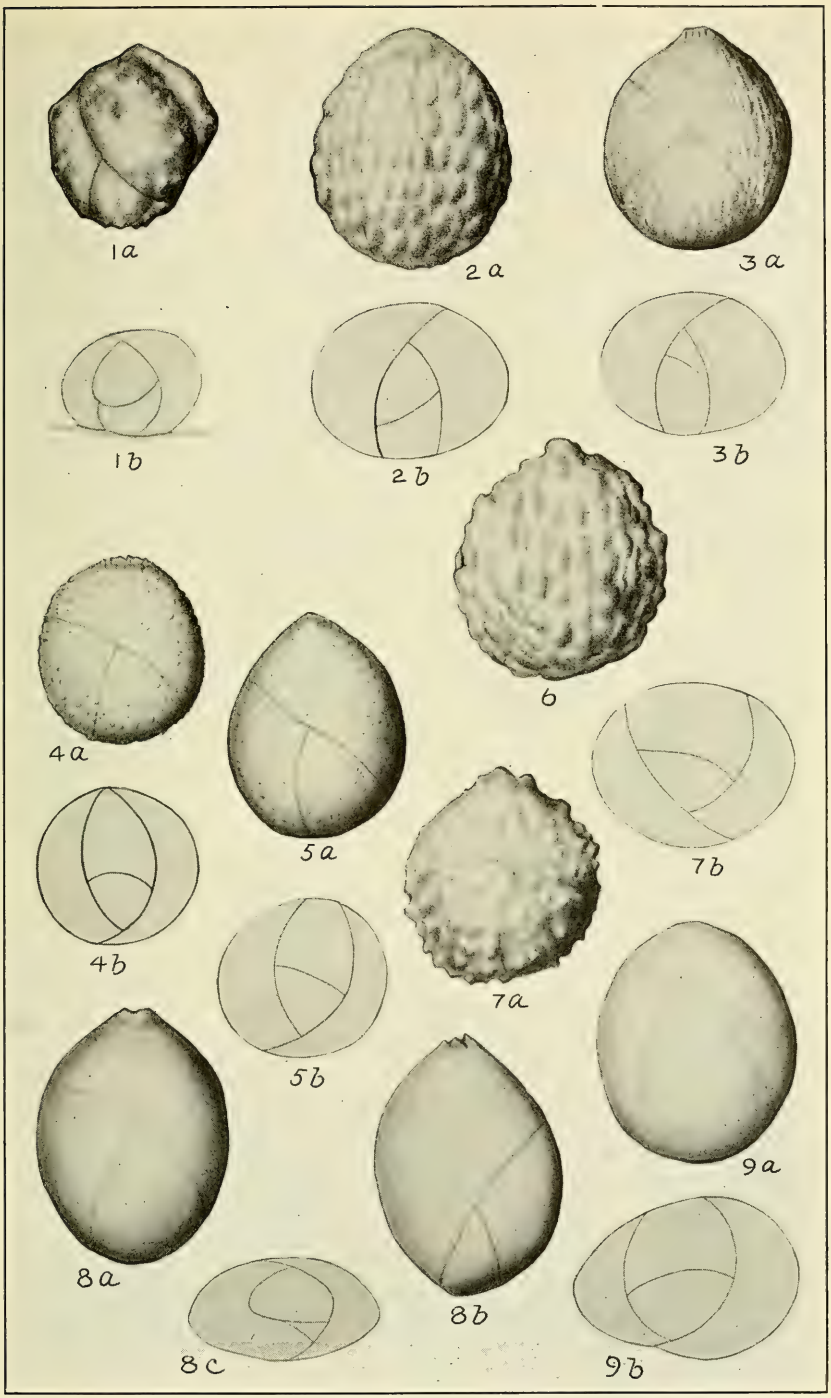
2. *Globulina gibba* d'Orbigny var. *verrucosa* Cushman and Ozawa, × 80. Eocene, Lutetien, Campbon, France. *a*, side view; *b*, basal view.

3. *Globulina gibba* d'Orbigny var. *fissicostata* Cushman and Ozawa. × 60. Upper Oligocene, Ahnatal, near Cassel, Germany.

4, 5. *Globulina gibba* d'Orbigny var. *punctata* d'Orbigny. × 45. 4, Eocene, Lutetien, Grignon, France. 5, Miocene, Tortonian, Vosslau, near Baden, Vienna, Austria.

6, 7. *Globulina gibba* d'Orbigny var. *tuberculata* d'Orbigny. × 35. Miocene, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, Vienna, Austria.

8, 9. *Globulina gibba* d'Orbigny var. *globosa* (v. Münster). × 45. 8, Miocene, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, Vienna, Austria. 9, upper Oligocene, Ahnatal, near Cassel, Germany.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

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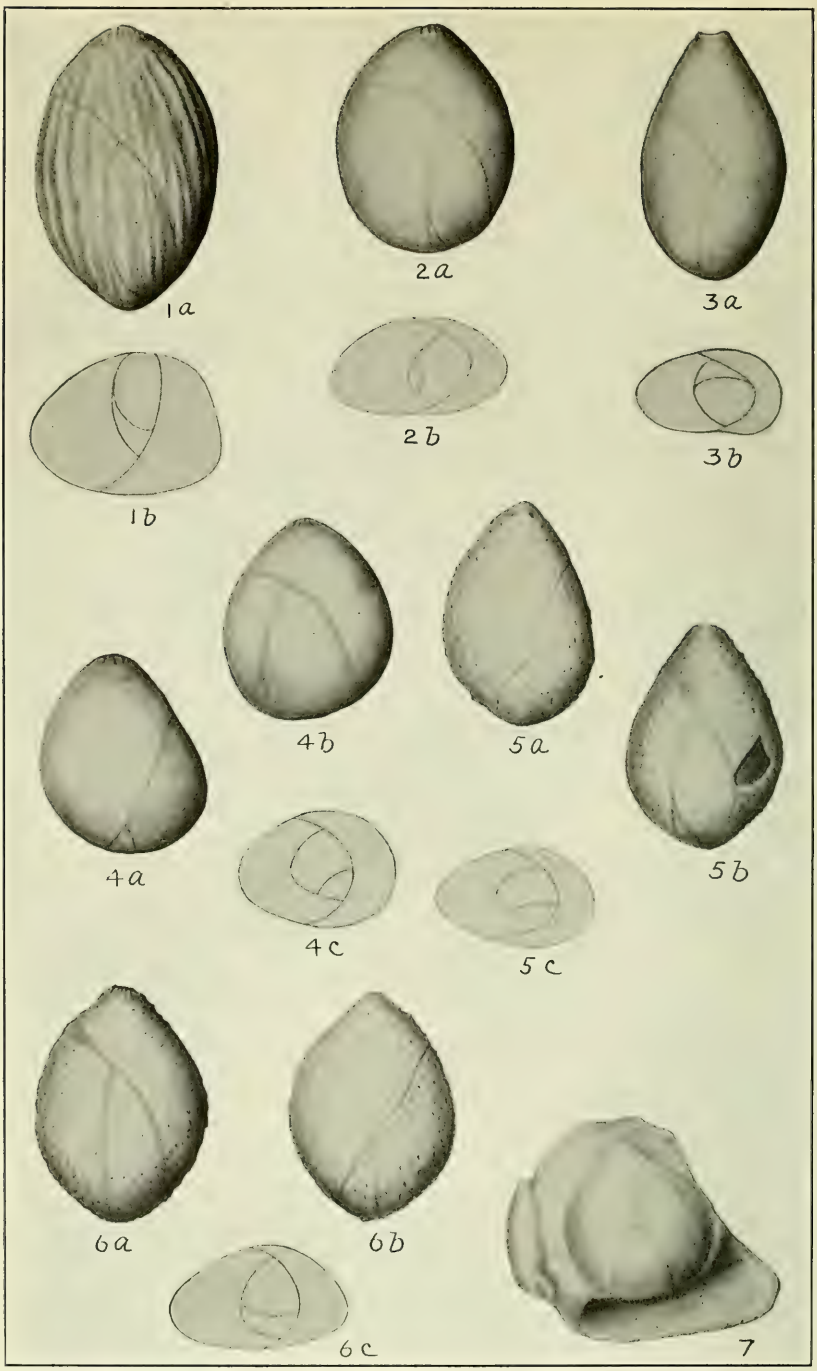


FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 163.

Plate 18

Fig. 1. *Globulina gibba* d'Orbigny var. *longitudinalis* Cushman and Ozawa, × 60. Pliocene, Castel Arquato, Italy. *a*, side view; *b*, basal view.

2–4. *Globulina inaequalis* Reuss. 2, × 45. Miocene, Tortonian sand, Strebersdorf, Bisamberg, near Vienna, Austria. 3, × 65. Eocene, Lutetien, Parnes (Les Bôves), France. 4, × 45. Middle Oligocene, Hermsdorf, near Berlin, Germany.

5, 6. *Globulina inaequalis* Reuss var. *caribaea* d'Orbigny. × 80. 5, off Dry Tortugas, Fla., 12 fathoms. 6, *Albatross* D2150, Caribbean Sea, 382 fathoms.

7. *Globulina inaequalis* Reuss var. *dollfussi* Cushman and Ozawa, × 45, Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France.

Plate 19

Figs. 1, 2. *Globulina lacrima* Reuss. 1, × 45. Cretaceous, upper Senonian, Dasbeck, near Hanover, Westphalia Germany. 2, × 65. Cretaceous, upper Senonian, Galling, near Siegsdorf, upper Bavaria, Germany.

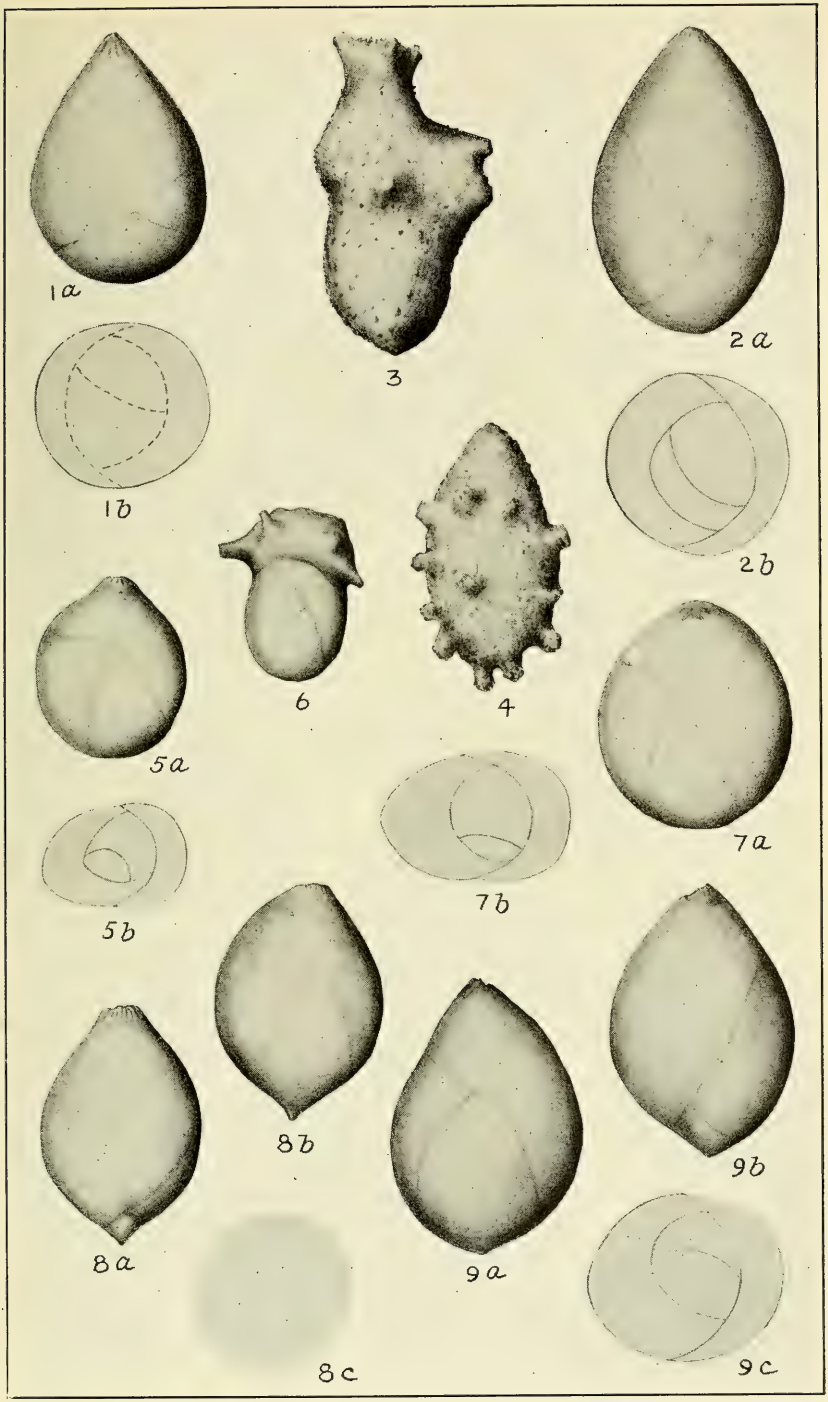
3. *Globulina lacrima* Reuss var. *horrida* Reuss. × 80. Cretaceous, upper Senonian, Galling, near Siegsdorf, upper Bavaria, Germany.

4. *Globulina lacrima* Reuss var. *ericia* Cushman and Ozawa. × 45. Cretaceous, chalk marl, Saxon Cement Works, Cambridge, England.

5–7. *Globulina lacrima* Reuss var. *subsphaerica* (Berthelin). × 80. 5, 6, Cretaceous, chalk marl, Saxon Cement Works, Cambridge, England. 7, Cretaceous, lower Gault, Storey's Way, Cambridge, England.

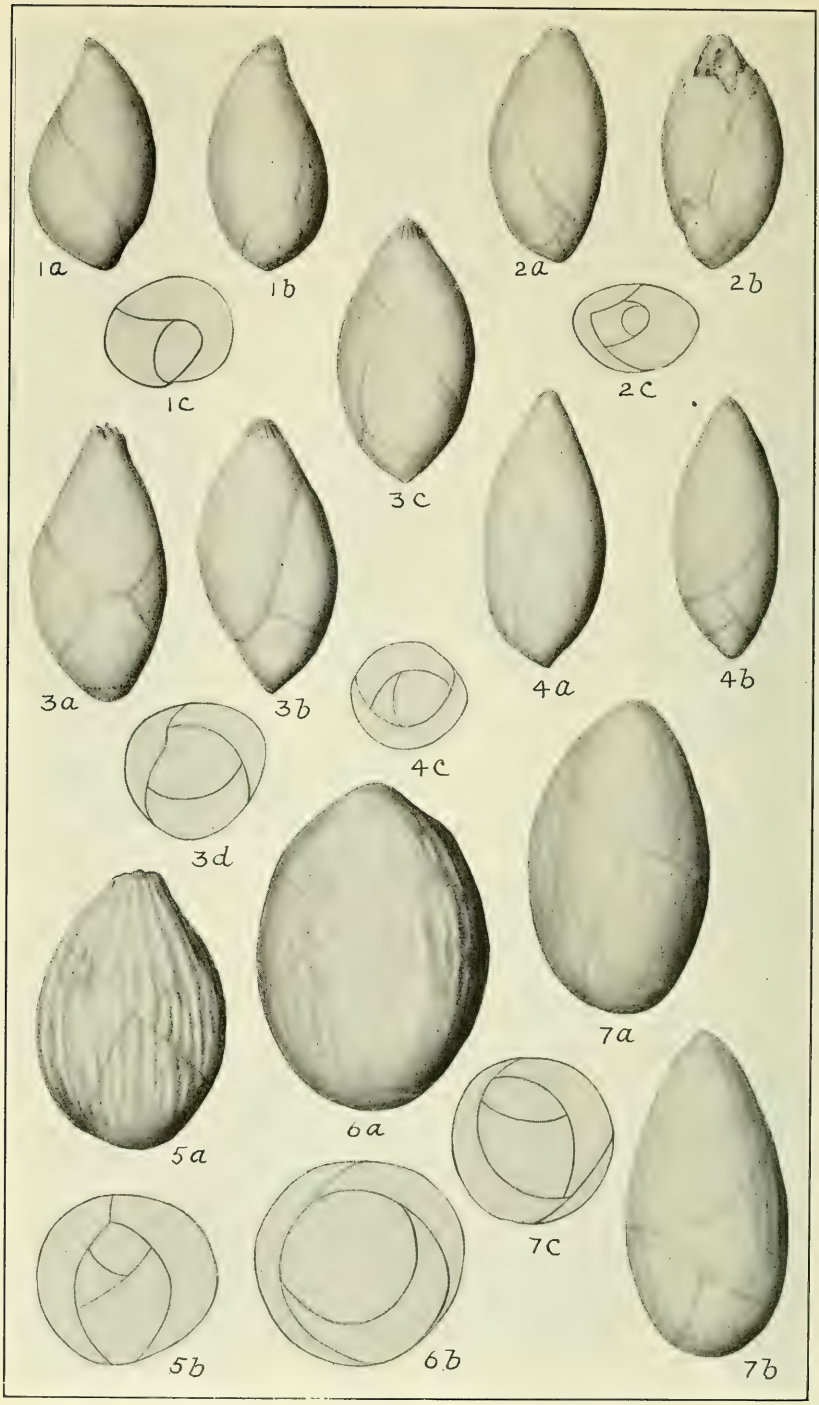
8. *Globulina gibba* d'Orbigny var. *cognata* (Franzenau). × 45. Pliocene, Sepik River, New Guinea. *a*, *b*, side views; *c*, basal view.

9. *Globulina ampulla* (Jones). × 80. Eocene, Bracklesham bed XVIII, White Cliff Bay, Isle of Wight, England. *a*, *b*, side views; *c*, basal view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 164.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 165.

Plate 20

Fig. 1. *Globulina flexa* Cushman and Ozawa. × 45. Upper Oligocene, Doberg, near Bünde, Germany. *a*, *b*, side views; *c*, basal view.

2. *Globulina exserta* (Berthelin). × 45. Cretaceous, chalk marl, Folkestone, England. *a*, *b*, side views; *c*, basal view.

3, 4. *Globulina minuta* (Roemer). 3, × 45. Oligocene, Düsseldorf, Germany. 4, × 65. Middle Oligocene, Hermsdorf, near Berlin, Germany.

5. *Globulina granulosa* Egger. × 45. Miocene, Burdigalien inferieur, Moulin de l'Eglise, Saucats, France.

6. *Globulina gibba* d'Orbigny var. *myristiformis* (Williamson). 80. Beach, Lido, Venice, Italy. *a*, side view; *b*, basal view.

7. *Globulina granulosa* Egger (?). × 45. Miocene, Burdigalien, St. Paul de Dax, near Bordeaux, France. *a*, *b*, side views; *c*, basal view.

Plate 21

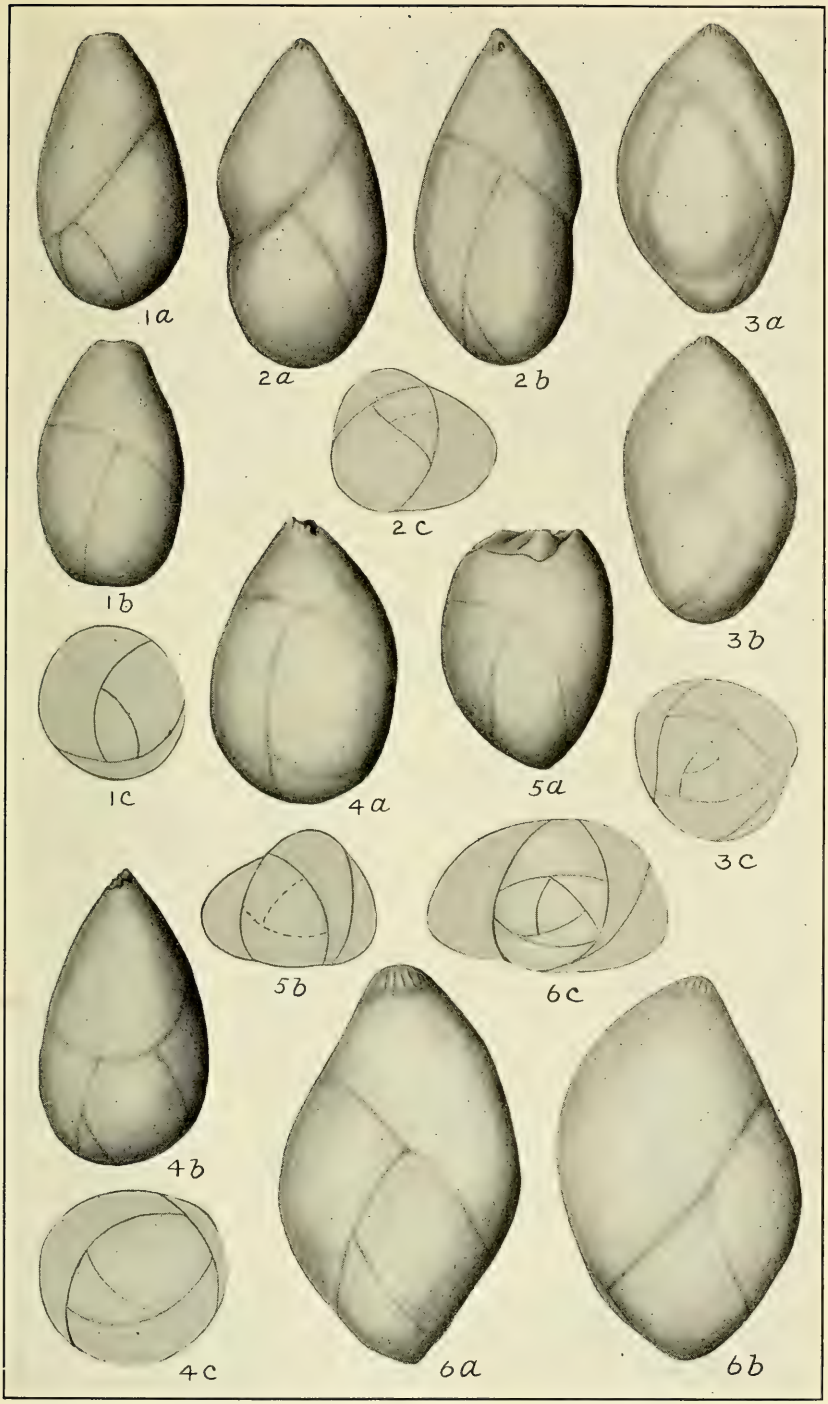
Fig. 1. *Globulina granulosa* Egger var. *polita* (Terquem.) × 45. Miocene, Tortonian, Strebersdorf, Bisamberg, Austria. *a*, *b*, side views; *c*, basal view.

2. *Globulina gravis* (Karrer). × 35. Cretaceous, upper Senonian, Maastricht, Holland.

3, 4. *Globulina rotundata* (Bornemann). × 35. 3, middle Oligocene, Hermsdorf, near Berlin, Germany. 4, upper Oligocene, Ahnatal, near Cassel, Germany.

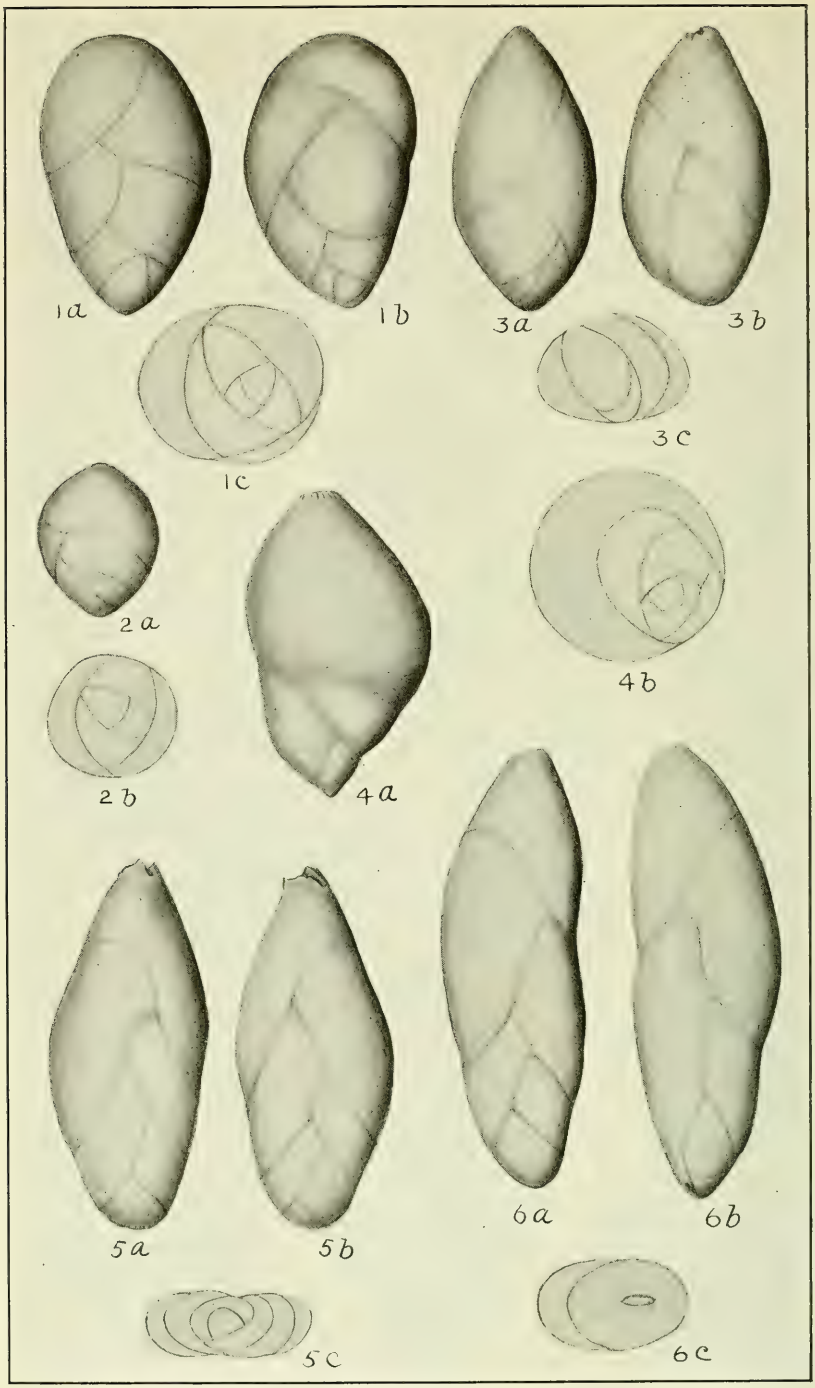
5. *Globulina ampla* (Karrer). × 45. Cretaceous, upper Senonian, Stemmerberg, Westphalia, Germany.

6. *Globulina consobrina* (Fornasini). × 45. Miocene, Tortonian, Grunes Kreuz, Nussdorf, near Vienna, Austria.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 166.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 167.

PLATE 22

FIGS. 1, 2. *Globulina triserialis* Cushman and Ozawa. × 45. 1, Miocene, Helvetien, Moulin du Minoy, Salles, France. 2, Burdigalien inferieur, Moulin de l'Eglise, Saucats, France.

3. *Globulina münsteri* (Reuss). × 65. Middle Oligocene, Doberg, near Bünde, Germany.

4. *Globulina* species. × 35. *Porcupine* Station 16, Eastern Atlantic.

5, 6. *Pseudopolymorphina ligua* (Roemer). × 30. 5, upper Oligocene, Ahnatal, near Cassel, Germany. 6, Pliocene, Crag, Sutton, England.

Plate 23

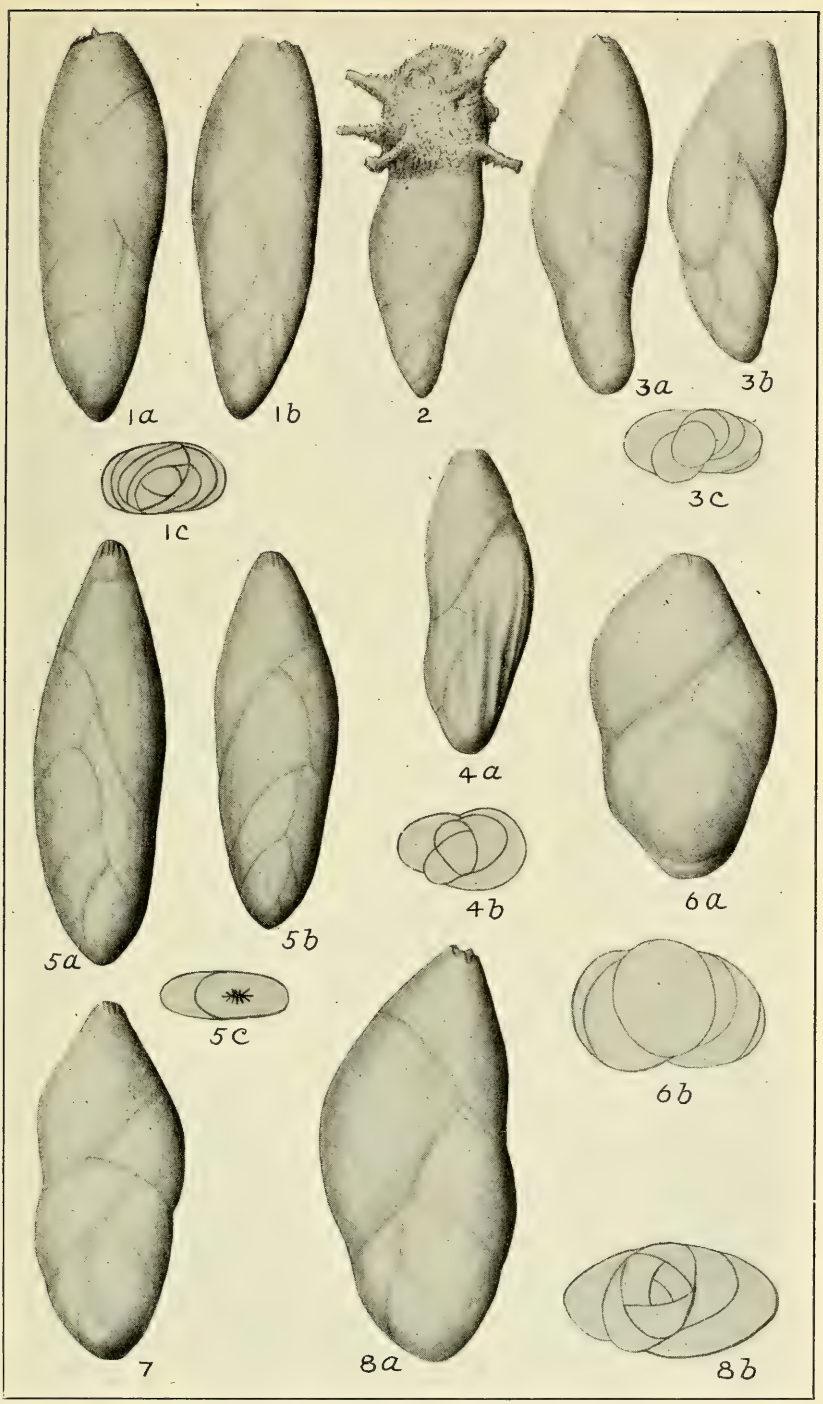
Figs. 1, 2. *Pseudopolymorphina novangliae* (Cushman). × 35. Off eastern coast United States. 2, Fistulose form.

3. *Pseudopolymorphina suboblonga* Cushman and Ozawa. × 35. Upper Pliocene, Okuwa, Province of Kaga, Japan. *a*, *b*, side views; *c*, basal view.

4. *Pseudopolymorphina suboblonga* Cushman and Ozawa var. *jugosa* Cushman and Ozawa. × 35. Recent, off Kobama, Japan. *a*, side view; *b*, basal view.

5. *Pseudopolymorphina striata* (Bagg). × 35. Miocene, Choptank formation, 1 mile above Governor Run, Chesapeake Bay, Md.

6–8. *Pseudopolymorphina soldanii* (d'Orbigny). × 35. 6, upper Oligocene, Ahnatal, near Cassel, Germany. 7, 8, Pliocene, Crag noir, Antwerp, Belgium.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

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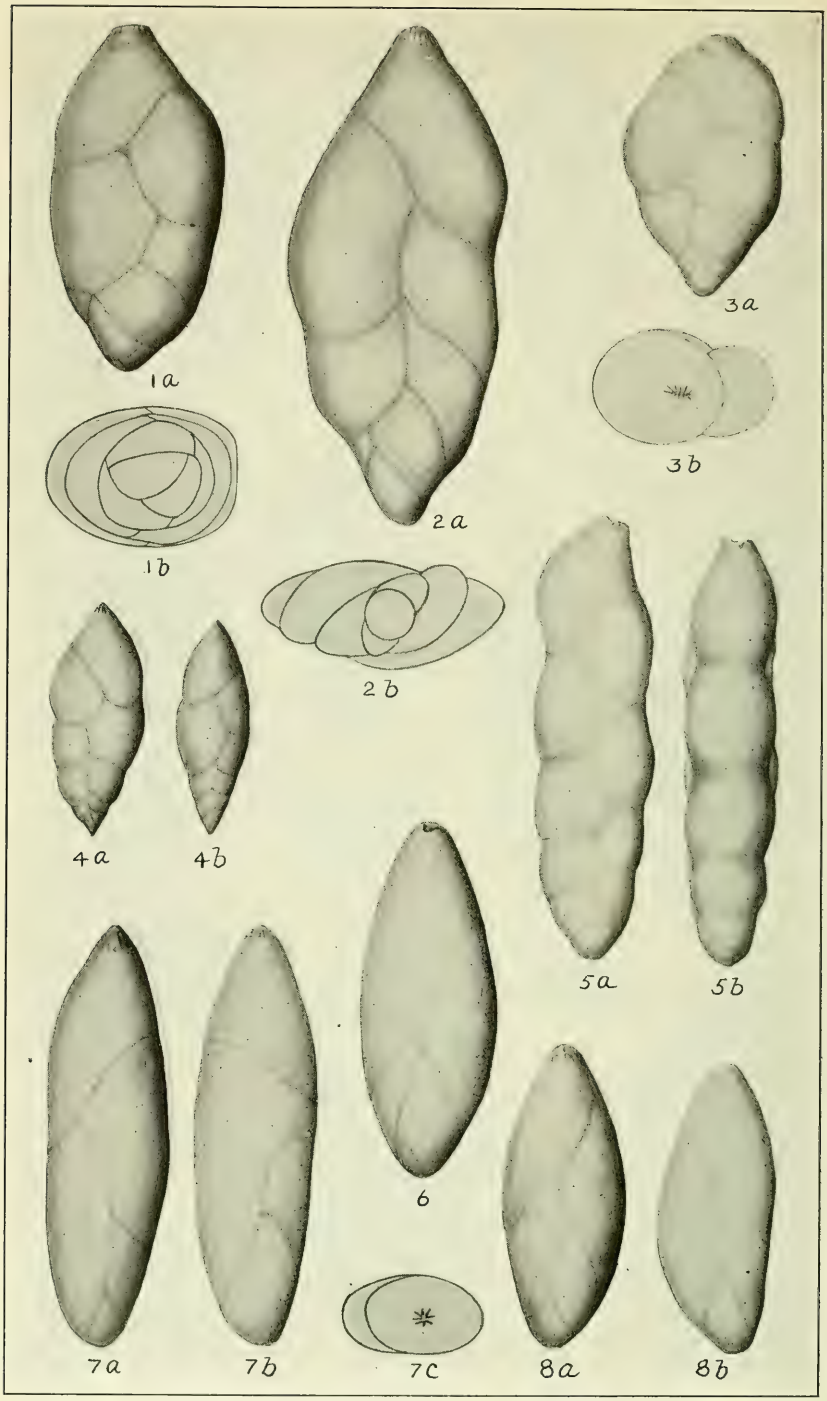


FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 169.

Plate 24

Fig. 1. *Pseudopolymorphina hanzawai* Cushman and Ozawa. × 25. Upper Pliocene, Sawane, Island of Sado, Japan. *a*, side view; *b*, basal view.

2. *Pseudopolymorphina atlantica* Cushman and Ozawa. × 35. *Albatross* D 2416, East coast, United States. *a*, side view; *b*, basal view.

3. *Pseudopolymorphina phaleropei* Cushman and Ozawa. × 45. Recent, Woods Hole Region. *a*, side view; *b*, apertural view.

4. *Pseudopolymorphina parva* (Clodius). (After Clodius.)

5. *Pseudopolymorphina doanei* (Galloway and Wissler). × 25. Pliocene, Timms Point, San Pedro, Calif. *a*, *b*, side views.

6–8. *Pseudopolymorphina decora* (Reuss). × 45. Miocene, Burdigalien inferieur, Moulin de l'Eglise, Saucats, France. *a*, *b*, side views; *c*, apertural view.

Palte 25

Fig. 1. *Pseudopolymorphina dumblei* (Cushman and Applin). × 65. Eocene Jacksonian, Bridge Creek, 1½ miles above Angelina River, Tex.

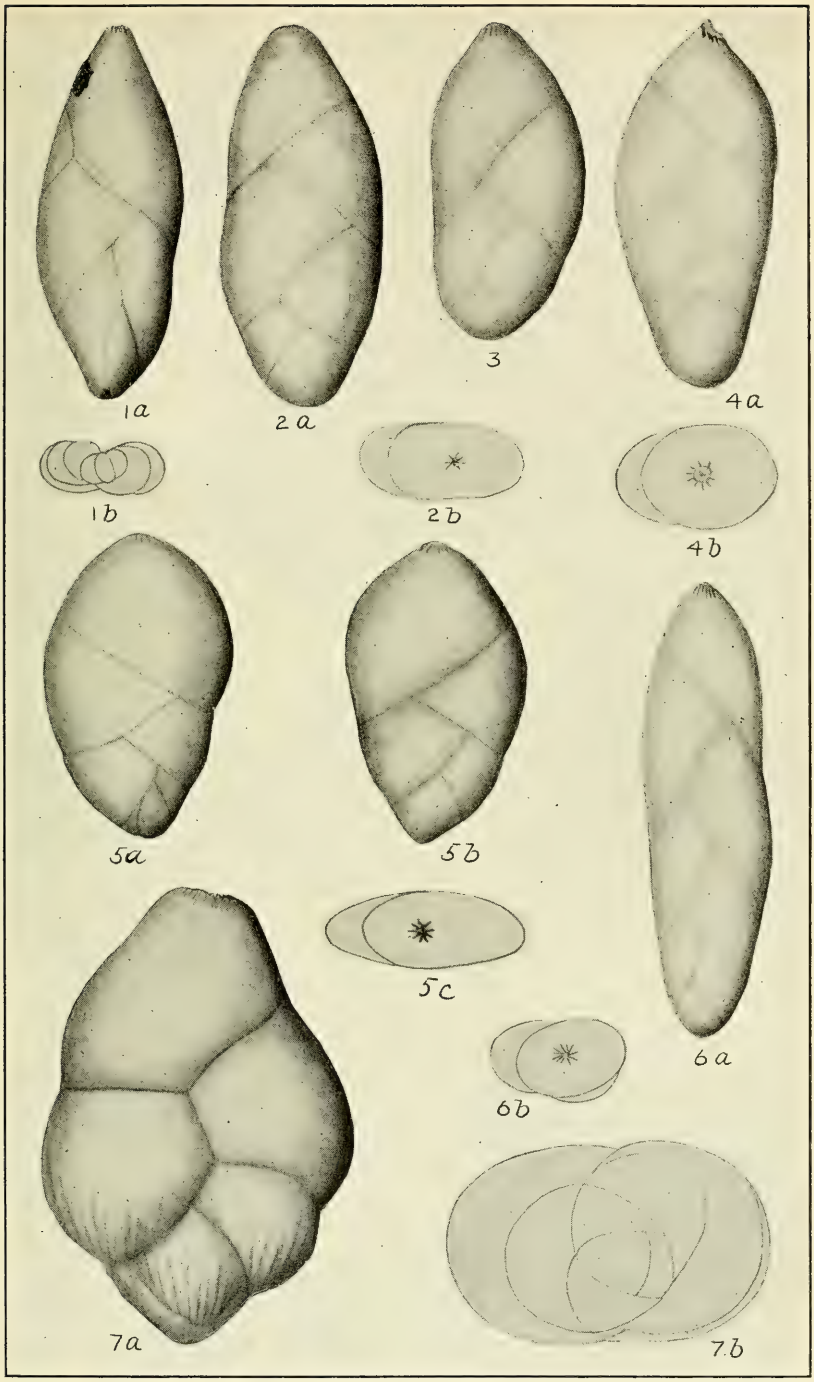
2, 3. *Pseudopolymorphina okuwaensis* Cushman and Ozawa. × 45. Upper Pliocene, Okuwa, Province of Kaga, Japan. *a*, side view; *b*, apertural view.

4. *Pseudopolymorphina ishikawaensis* Cushman and Ozawa. × 35. Upper Pliocene, Okuwa, Province of Kaga, Japan. *a*, side view; *b*, apertural view.

5. *Pseudopolymorphina zeuschneri* (Reuss). × 45. Miocene, Tortonian sand, Varpolata, Hungary. *a*, *b*, side views; *c*, apertural view.

6. *Pseudopolymorphina ishikawaensis* Cushman and Ozawa. × 25. Upper Pliocene, Natsukawa, Province of Echigo, Japan. *a*, side view; *b*, apertural view.

7. *Pseudopolymorphina indica* (Cushman). × 35. *Albatross* D5579, off Sibuko Bay, Borneo.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

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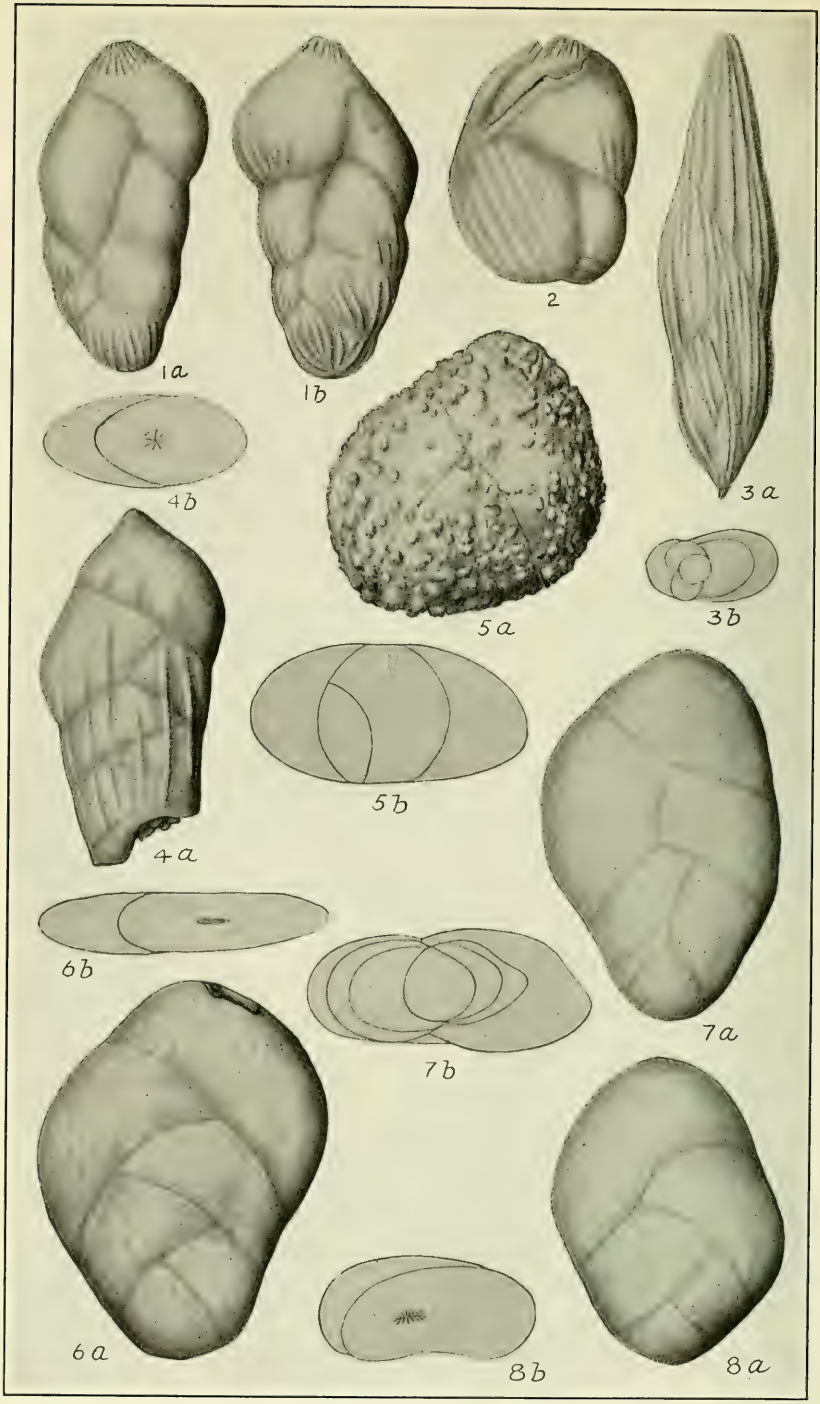


FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 171

Plate 26

Figs. 1, 2. *Pseudopolymorphina indica* (Cushman) var. *japonica* Cushman and Ozawa. 1, × 25. Recent, *Albatross* D4807, 44 fathoms, off Cape Tsiuka, Japan. 2, × 35. Miocene, specimen doubtfully belonging here (=*P. costata* Allix), Pontlevoy, France. *a*, *b*, side views.

3. *Pseudopolymorphina rutila* (Cushman). × 65. Lower Oligocene, Byram marl, Leaf River, Miss. *a*, side view; *b*, basal view.

4. *Pseudopolymorphina paucicostata* Cushman and Ozawa. × 45. Eocene, Midwayan, Texas.

5, 6. *Pseudopolymorphina variata* (Jones, Parker, and H. B. Brady). × 30. 5, Pliocene, Crag, Sutton, England. 6, Miocene, Helvetian, Pontlevoy, France.

7, 8. *Pseudopolymorphina variata* (Jones, Parker, and H. B. Brady) var. *fischeri* (Terquem). × 25. 7, Pliocene, Crag, Sutton, England. *a*, side view; *b*, basal view. 8, Miocene, Helvetian, Pontlevoy, France. *a*, side view; *b*, apertural view.

Plate 27

Fig. 1. *Pseudopolymorphina ovalis* Cushman and Ozawa. × 35. Miocene, Tortonian, Brickyard at Baden, near Vienna, Austria. *a*, *b*, side views; *c*, basal view.

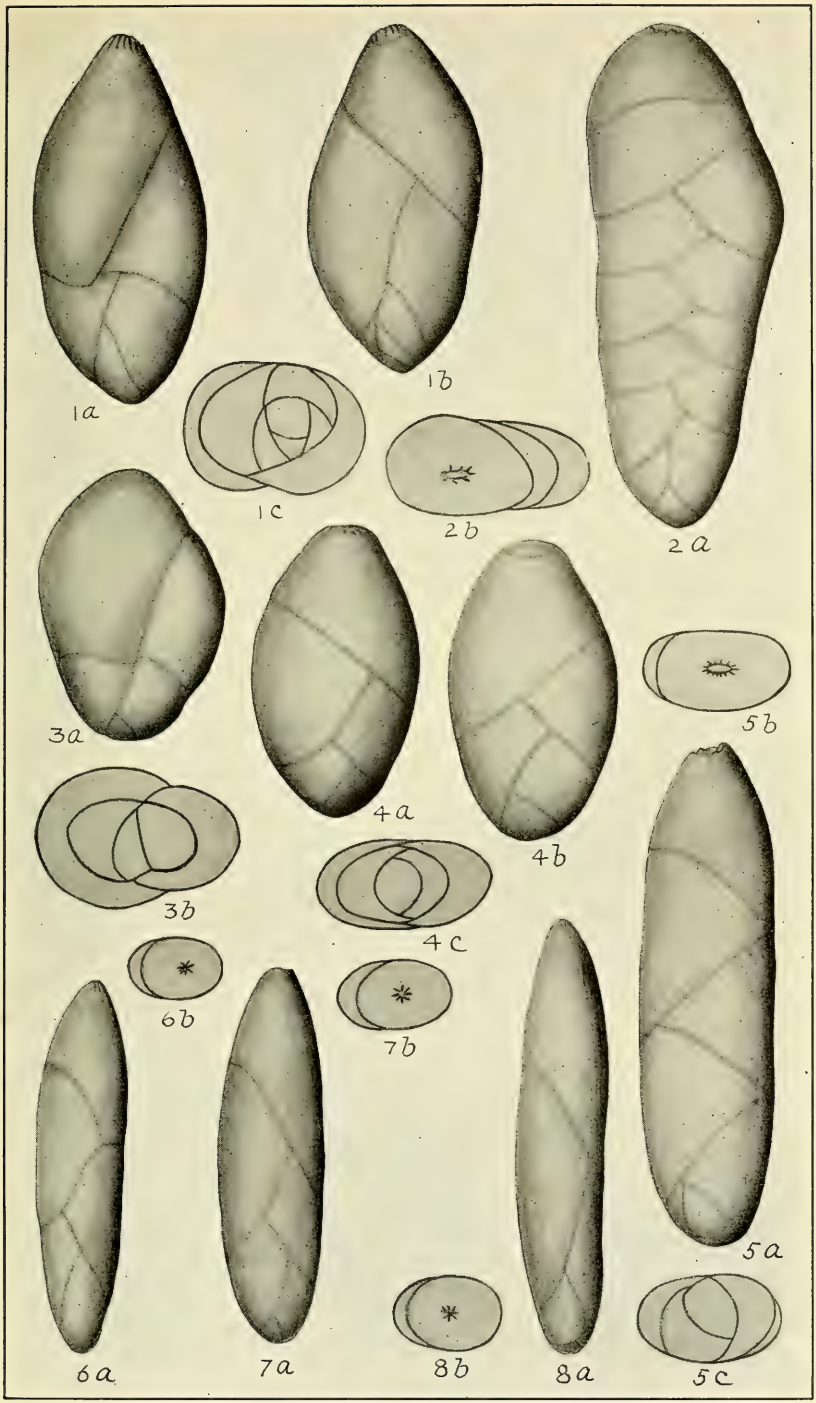
2. *Pseudopolymorphina obscura* (Roemer). × 12. Upper Oligocene, Ahnatal, near Cassel, Germany. *a*, side view; *b*, apertural view.

3. *Pseudopolymorphina curta* Cushman and Ozawa. × 60. Recent, Casco Bay, Me. 32 fathoms. *a*, side view; *b*, basal view.

4, 5. *Pseudopolymorphina spatulata* (Terquem). × 35. 4, Miocene, Aquitanian superieur, St. Avit, near Mont de Marsan, France. Young. 5, Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. Adult. *a*, side view; *b*, apertural view; *c*, basal view.

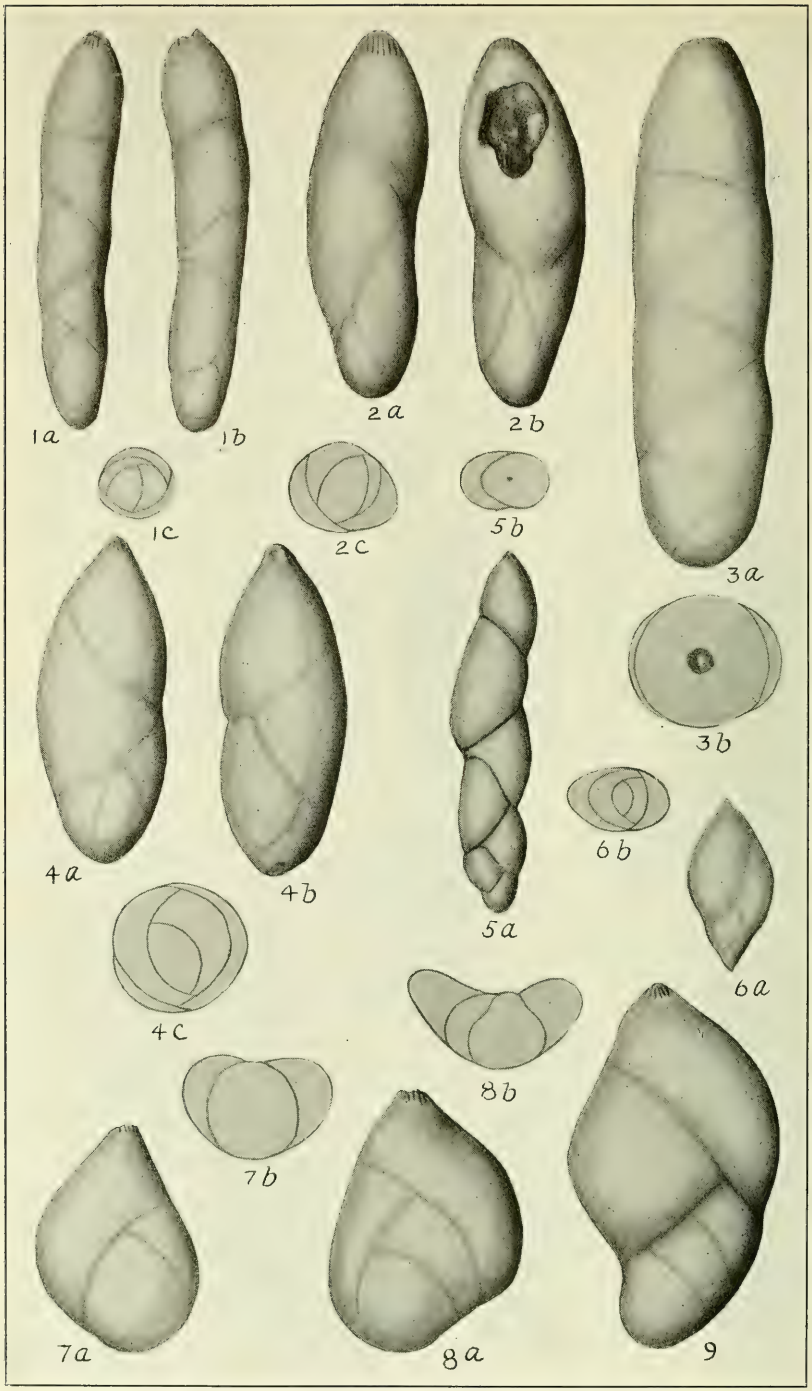
6, 7. *Pseudopolymorphina dollfussi* Cushman and Ozawa. × 35. 6, holotype, Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. *a*, side view; *b*, apertural view. 7, Miocene, Aquitanian superieur, St. Avit, near Mont de Marsan, France. *a*, side view; *b*, apertural view.

8. *Pseudopolymorphina dollfussi* Cushman and Ozawa var. *tenuistriata* Cushman and Ozawa. × 45. Miocene, St. Paul de Dax, near Bordeaux, France. *a*, side view; *b*, apertural view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 172.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 173.

Plate 28

Fig. 1. *Pseudopolymorphina jonesi* Cushman and Ozawa. × 25. Miocene, St. Paul de Dax, near Bordeaux, France. *a*, *b*, side views; *c*, basal view.

2. *Pseudopolymorphina subcylindrica* (Hantken). × 35. Miocene, Tortonian, *Amphistegina* marl, Nussdorf, near Vienna, Austria. *a*, *b*, side views; *c*, basal view.

3. *Pseudopolymorphina digitata* (d'Orbigny). × 35. Cretaceous, upper Senonian, Maastricht, Holland. *a*, side view; *b*, apertural view.

4. *Pseudopolymorphina leopolitana* (Reuss). × 35. Cretaceous, Cambridge greensand, Saxon Cement Works, Cambridge, England. *a*, *b*, side views; *c*, basal view.

5. *Paleopolymorphina pleurostomelloides* (Franke). × 65. Cretaceous, lower Cenomanian, Tecklenberg, Westphalia, Germany. *a*, side view; *b*, apertural view.

6. *Paleopolymorphina gaultina* (Berthelin). × 80. Cretaceous, Gault, Folkestone, England. *a*, side view; *b*, basal view.

7–9. *Pseudopolymorphina mendezensis* (White). × 45. Upper Cretaceous, Navarro formation, clay pit at Corsicana, Tex. Various stages in development; *b*, basal view.

Plate 29

Fig. 1. *Pyrulina velascoensis* (Cushman). × 65. Cretaceous, Velasco shale, Hacienda El Limon, west of Panuco, Mexico. *a–c*, side views.

2. *Pseudopolymorphina subnodosa* (Reuss). (After Reuss.)

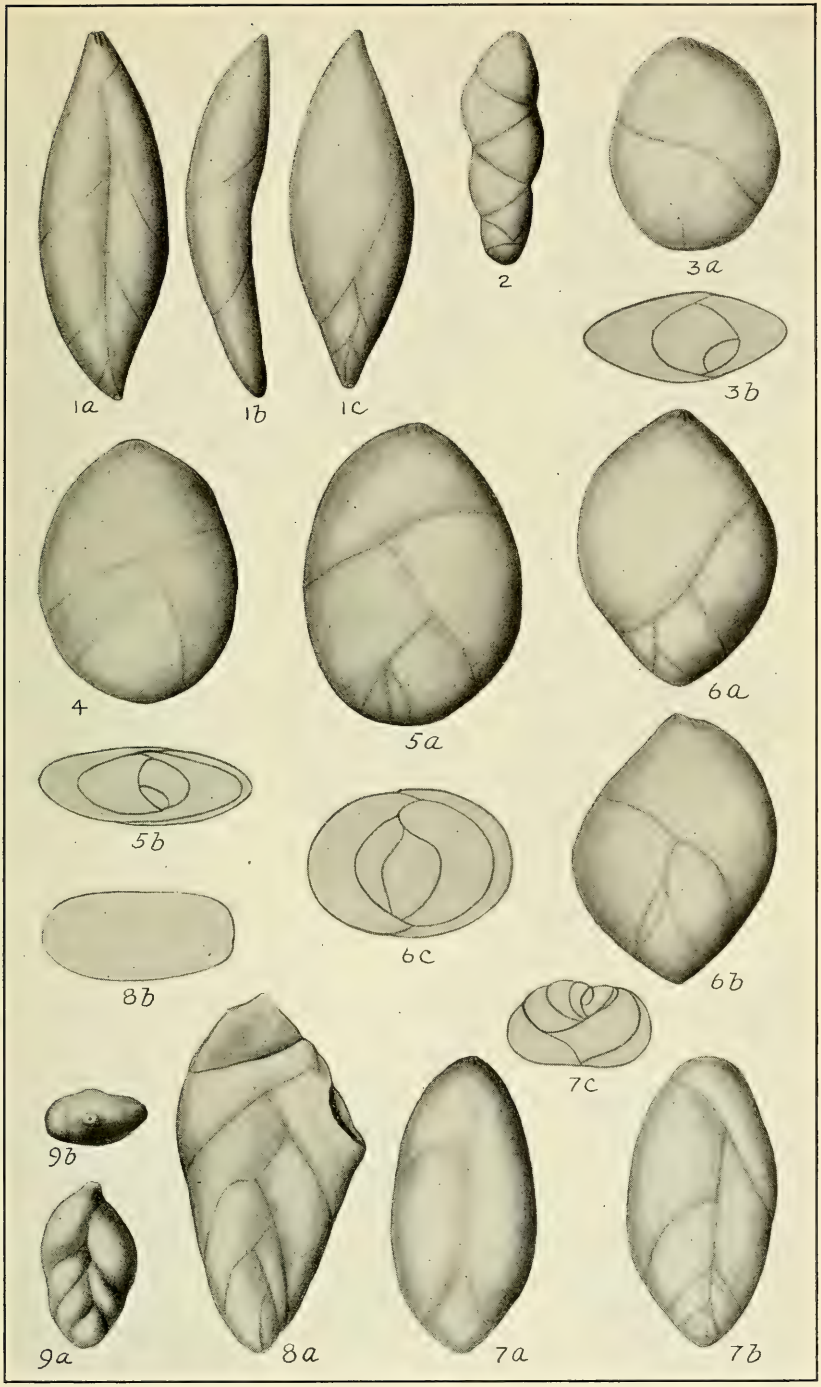
3–5. *Pseudopolymorphina incerta* (Egger). × 45. Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. *a*, side view; *b*, basal view.

6. *Pseudopolymorphina ovalis* Cushman and Ozawa. × 35. Miocene, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna, Austria. *a*, *b*, side views; *c*, basal view.

7. *Polymorphina burdigalensis* d'Orbigny. × 45. Miocene, Burdigalien inferieur, Moulin de l'Eglise, Saucats, France. *a*, *b*, side views; *c*, basal view.

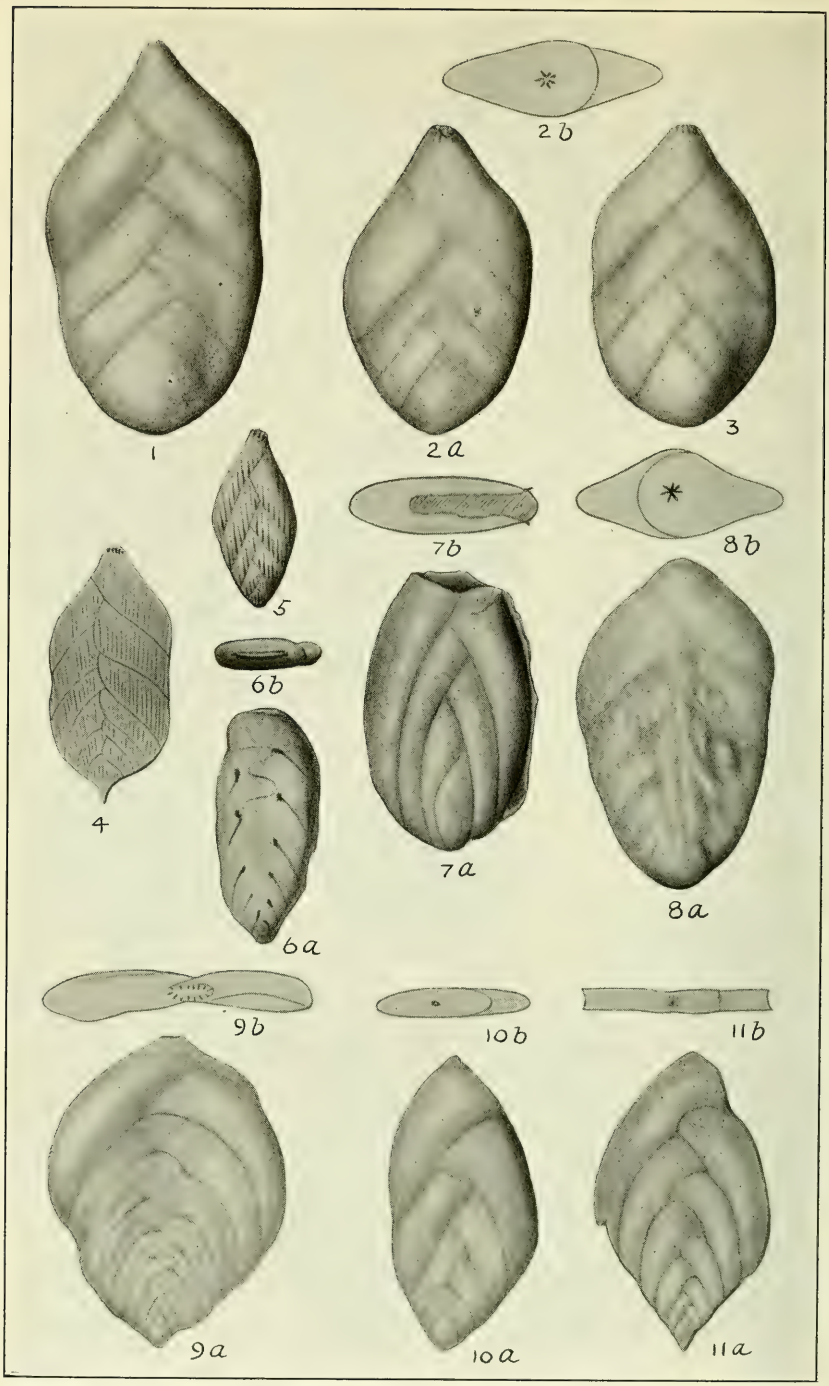
8. *Polymorphina fornasinii* Cushman and Ozawa. × 40. Recent, off Tripoli. *a*, side view; *b*, outline of end view.

9. *Polymorphina incavata* Stache. × 15. (After Stache.) *a*, side view; *b*, apertural view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 174.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 175.

Plate 30

Figs. 1–3. *Polymorphina subrhombica* Reuss. × 25. Eocene, Vincentown, N. J. *b*, apertural view.

4. *Polymorphina aculeata* d'Orbigny. (After d'Orbigny.)

5. *Polymorphina longistriata* Cushman and Ozawa. × 25. (After Burrows and Holland.) Eocene, Thanetian, Pegwell Bay, England.

6. *Polymorphina parallela* Millett. × 90. (After Millett.) Pliocene, St. Erth, England.

7. *Polymorphina alleni* Cushman and Ozawa. × 60. Eocene, Brackle-sham bed XVII, White Cliff Bay, Isle of Wight, England. *a*, side view; *b*, outline of end view.

8. *Polymorphina cushmani* Plummer. × 25. Eocene, Midwayan, 5¼ miles due south and very slightly west of Littig, Tex. *a*, side view; *b*, apertural view.

9. *Polymorphina complanata* d'Orbigny. × 35. Miocene, Tortonian, *Amphistegina* marl, Grunes Kreuz, Nussdorf, near Vienna, Austria. *a*, side view; *b*, apertural view.

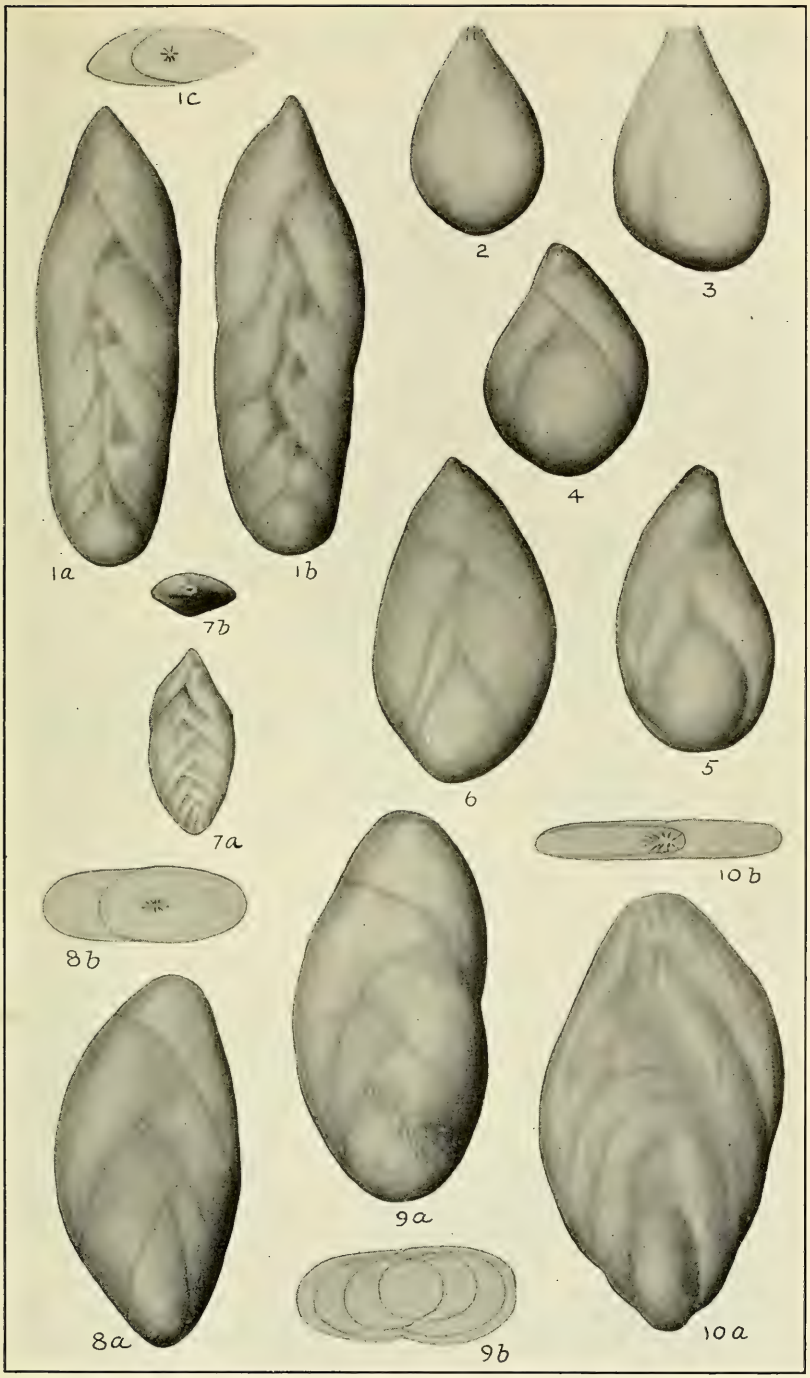
10. *Polymorphina advena* Cushman. × 80. Lower Oligocene, Mint Spring marl, at waterfall in Mint Spring Bayou, Vicksburg, Miss. *a*, side view; *b*, apertural view.

11. *Polymorphina frondea* (Cushman). × 80. Lower Oligocene, Byram marl, Byram, Miss. *a*, front view; *b*, apertural view.

Plate 31

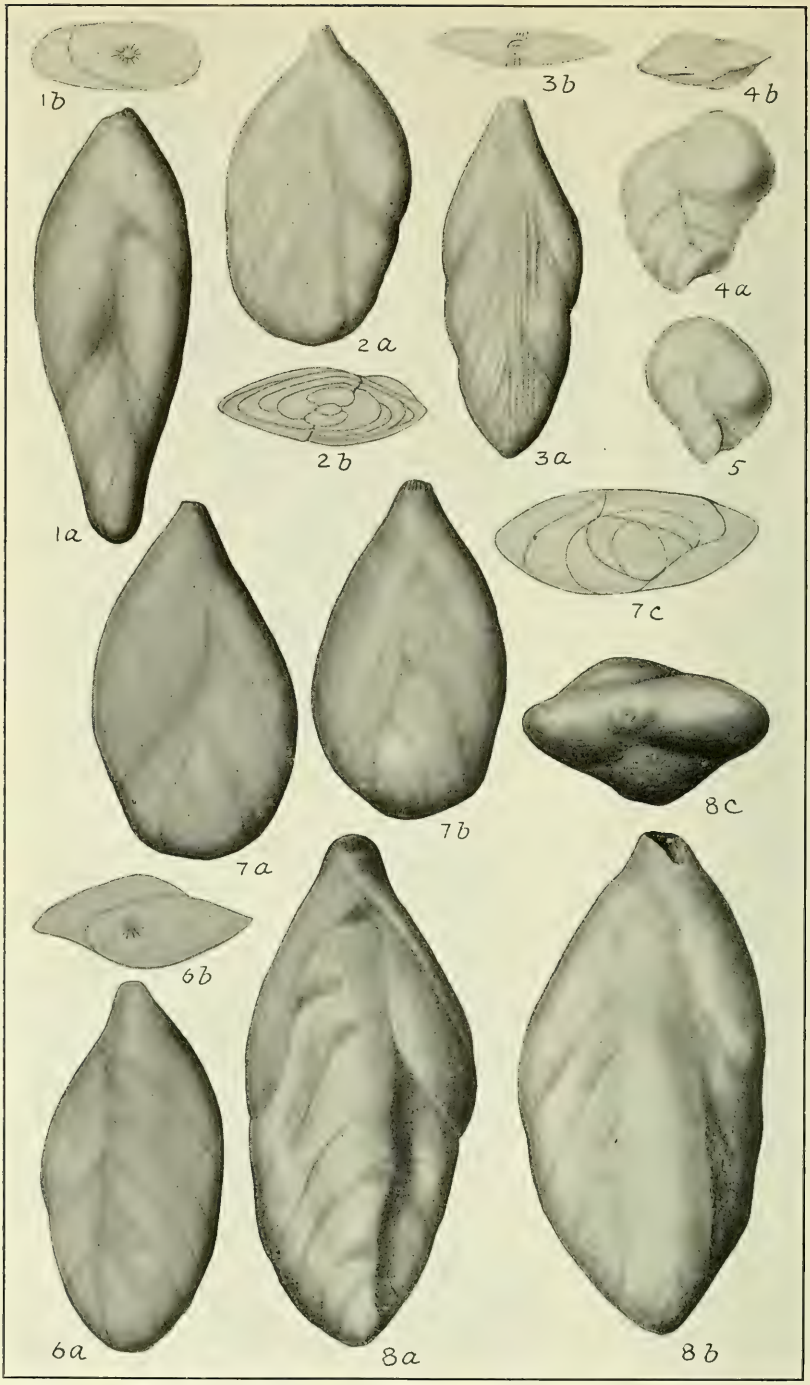
Figs. 1–6. *Polymorphina charlottensis* Cushman. 1, Pliocene, Timms Point, San Pedro, Calif. × 25. *a*, *b*, side views; *c*, apertural view. 2–6, upper Pliocene, Natsukawa, Province of Echigo, Japan, showing early stages in development. × 45.

7. *Polymorphina lingulata* Stache. × 20. (After Stache.) *a*, front view; *b*, end view.
8. *Polymorphina schlumbergeri* Cushman and Ozawa. × 45. Miocene, Aquitanian superieur, St. Avit, near Mont de Marson, near Bordeaux, France. *a*, side view; *b*, apertural view.
9. *Polymorphina howchini* Cushman and Ozawa. × 25. Lower Pliocene, McDonald's, Muddy Creek, Hamilton, Victoria, Australia. *a*, side view; *b*, basal view.
10. *Polymorphina frondiformis* Searles Wood. × 25. Pliocene, Crag Sutton, England. *a*, side view; *b*, apertural view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 176.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 177.

Plate 32

Fig. 1. *Sigmomorphina nysti* (Reuss). × 45. Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. *a*, side view; *b*, apertural view.

2. *Sigmomorphina jacksonensis* (Cushman). × 35. Eocene, Ocala limestone, loose blocks along road near Blue Springs, Jackson County, Fla. *a*, side view; *b*, basal view.

3. *Sigmomorphina jacksonensis* (Cushman) var. *costifera* (Cushman). × 35. Eocene, Jacksonian, Barnwell County, S. C. *a*, side view; *b*, apertural view.

4, 5. *Sigmomorphina chapmani* (Heron-Allen and Earland). × 20. (After Heron-Allen and Earland.) Filter quarry, Batesford, Victoria, Australia.

6. *Sigmomorphina nuttalli* Cushman and Ozawa. × 45. Eocene, Mount Moriah beds, yellow sandy clay overlying orbitoidal limestone, Vistabella quarry, Trinidad, British West Indies. *a*, side view; *b*, apertural view.

7. *Sigmomorphina flintii* (Cushman). × 25. Off Atlantic coast of Carolina, 440 fathoms. *a*, *b*, side views; *c*, basal view.

8. *Sigmomorphina pseudoregularis* Cushman and Thomas. × 25. Eocene, 17½ miles south of Palestine Road on Grapeland Road, first creek crossed by fording north of Grapeland, Houston County, Tex. *a*, *b*, side views; *c*, apertural view.

Plate 33

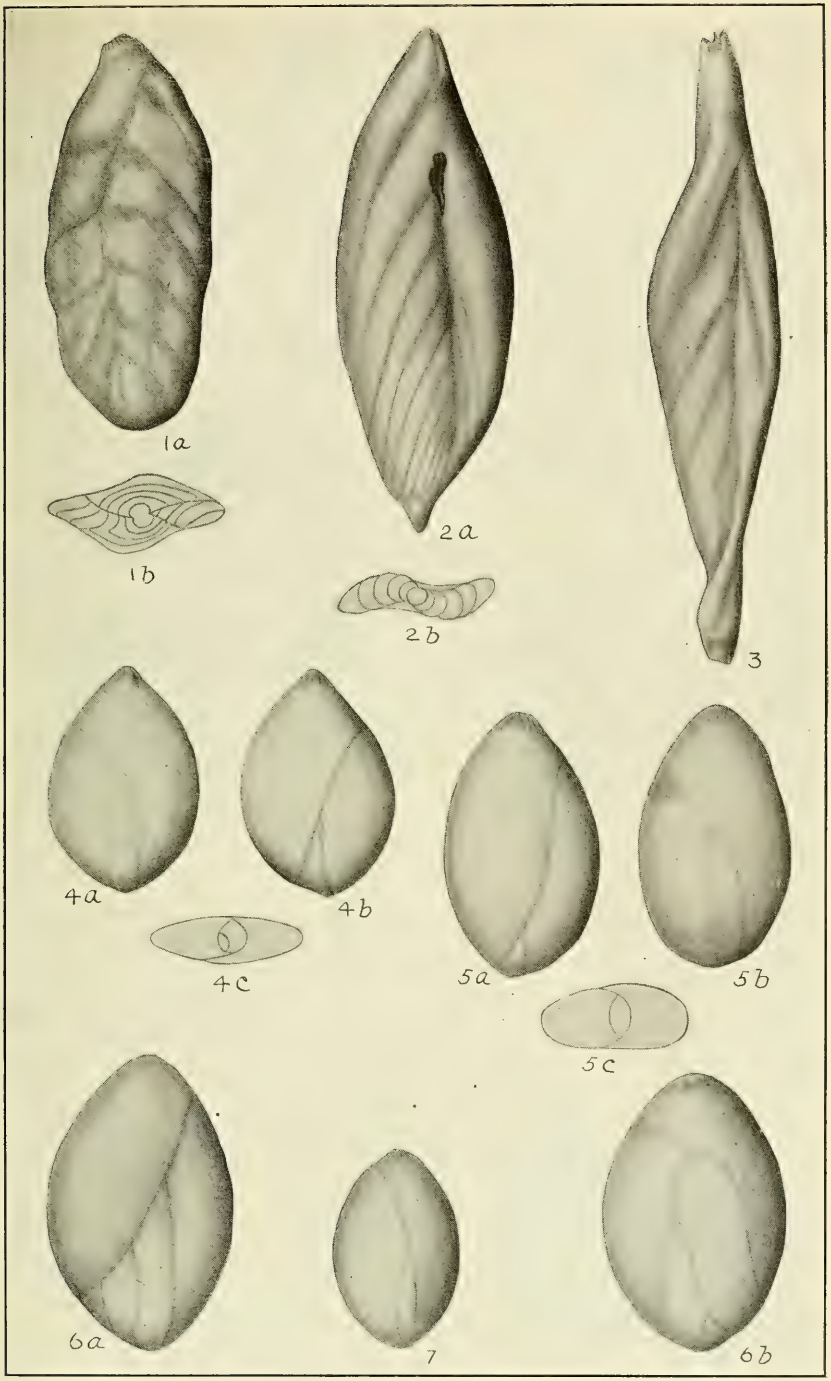
Fig. 1. *Sigmomorphina regularis* (v. Münster). × 12. Upper Oligocene, Ahnatal, near Cassel, Germany. *a*, side view; *b*, basal view.

2. *Sigmomorphina frondicula riformis* (Galloway and Wissler). × 35. Pliocene, Timms Point, San Pedro, Calif. *a*, side view; *b*, basal view.

3. *Sigmomorphina torta* (Galloway and Wissler). × 45. Pleistocene, Lomita quarry, Palos Verdes Hills, Calif.

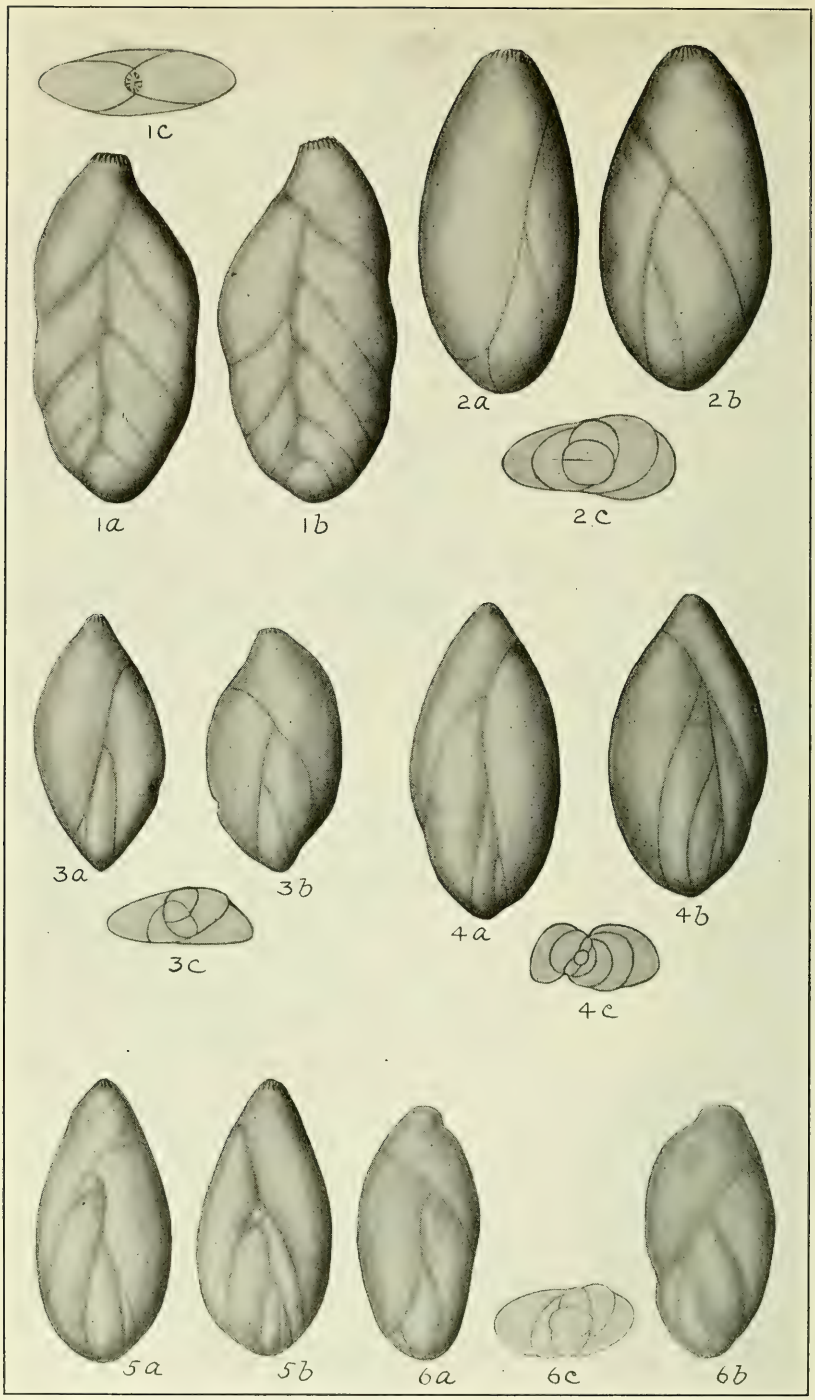
4, 5. *Sigmomorphina semitecta* (Reuss) var. *terquemiana* (Fornasini). 4, Pliocene, Castel Arquato, Italy. × 80. *a*, *b*, side views; *c*, basal view. 5, Eocene, Lutetian, middle bed, Grignon, France. × 80.

6, 7. *Sigmomorphina semitecta* (Reuss). × 65. Miocene, Burdigalien inferieur, de l'Eglise, Saucats, France. *a*, *b*, side views. 7, young.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 178.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 179.

Plate 34

Fig. 1. *Sigmomorphina schwageri* (Karrer). × 25. Miocene, Burdigalien inferieur, Le Coquillat, Leognan, France. *a*, *b*, side views; *c*, apertural view.

2, 3. *Sigmomorphina semitecta* (Reuss) var. *terquemiana* (Fornasini). 2, Miocene, Burdigalien inferieur, Moulin de l'Eglise, Saucats, France. × 65. 3, Pliocene, Castel Arquato, Italy. × 60.

4, 5. *Sigmomorphina undulosa* (Terquem). × 65. From *Lord Bandon* dredgings, off S.W. Ireland. *a*, *b*, side views; *c*, basal view.

6. *Sigmomorphina lamarcki* Cushman and Ozawa. × 45. Eocene, Lutetien, Campbon, France. *a*, *b*, side views; *c*, basal view.

Plate 35

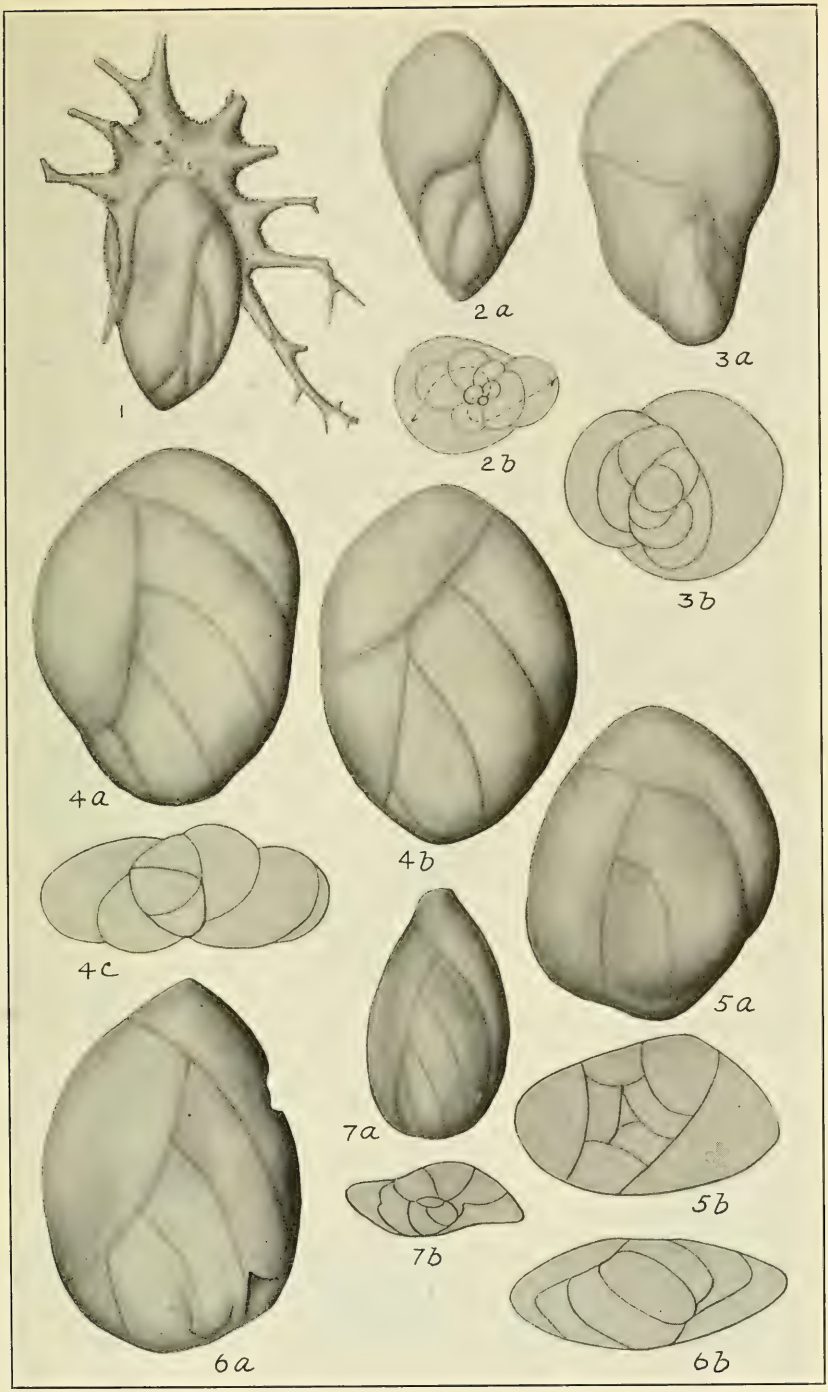
Fig. 1. *Sigmomorphina semitecta* (Reuss) var. *terquemiana* (Fornasini). × 35. Gulf of Sidra.

2, 3. *Sigmomorphina pearceyi* Cushman and Ozawa. 2, holotype. Recent, Dry Tortugas, Fla., 10 fathoms. × 80. 3, Eocene, Bartonian, Val di Lonte, Italy. × 45. *a*, side view; *b*, basal view.

4, 5. *Sigmomorphina crassa* (Roemer). × 25. Upper Oligocene, Ahnatal, near Cassel, Germany.

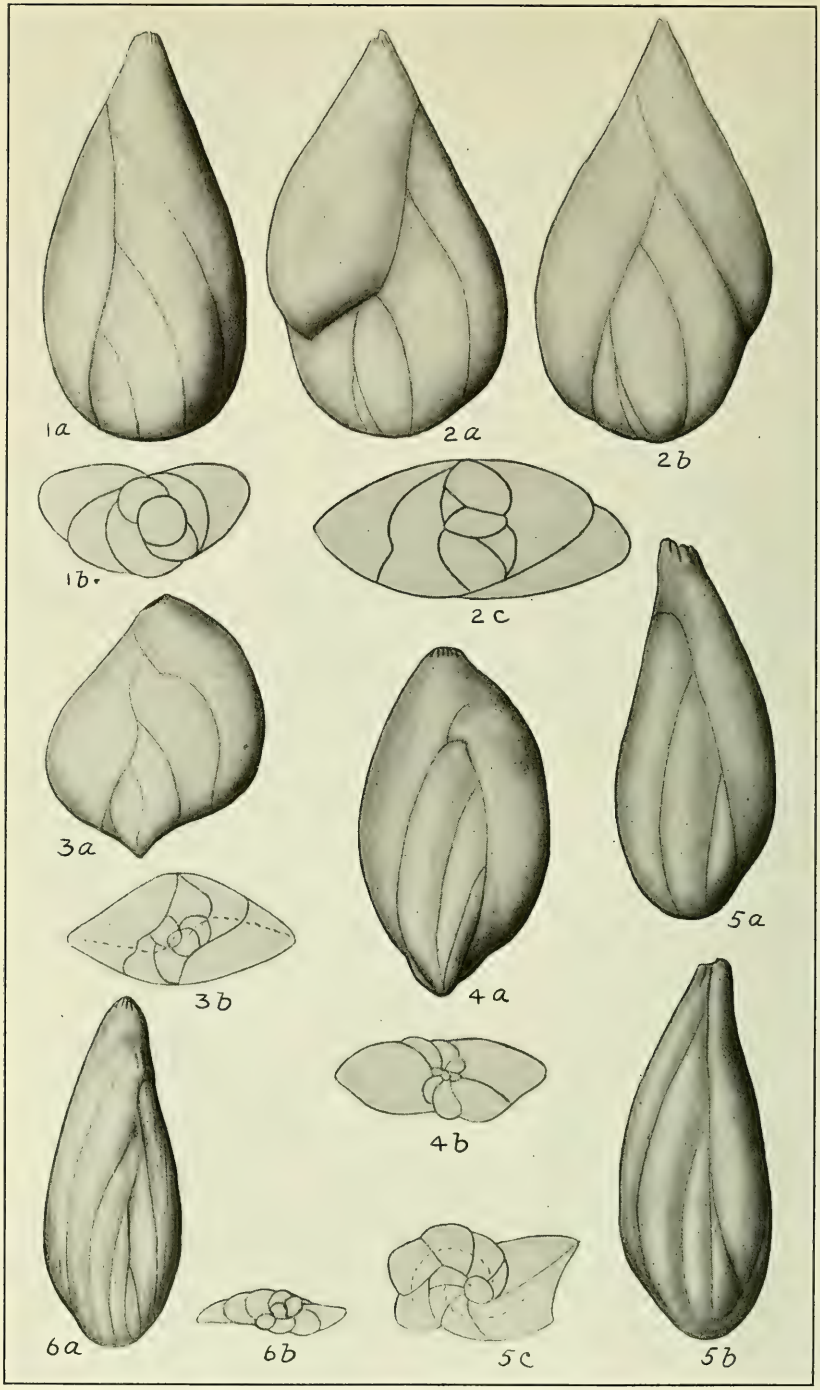
6. *Sigmomorphina schencki* Cushman and Ozawa. × 35. Oligocene, Keasey shale, 1 mile below Keasey post office, Rock Creek, Columbia County, Oreg. *a*, side view; *b*, basal view.

7. *Sigmomorphina kotoi* Cushman and Ozawa. × 45. Upper Pliocene, Natsukawa, Province of Echigo, Japan. *a*, side view; *b*, basal view.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 180.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 181.

Plate 36

Figs. 1, 2. *Sigmomorphina trinitatensis* Cushman and Ozawa. × 35. Hermitage quarry, Dumfries Road, Trinidad.

3. *Sigmomorphina bornemanni* Cushman and Ozawa. × 35. Middle Oligocene, Hermsdorf, near Berlin, Germany. *a*, side view; *b*, basal view.

4. *Sigmomorphina gallowayi* Cushman and Ozawa. × 45. *Albatross* D4807, off Japan. *a*, side view; *b*, basal view.

5. *Sigmomorphina trilocularis* (Bagg). × 45. *Albatross* D4807, off Japan.

6. *Sigmomorphina yokoyamai* Cushman and Ozawa. × 45. Upper Pliocene, Island of Sado, Japan. *a*, side view; *b*, basal view.

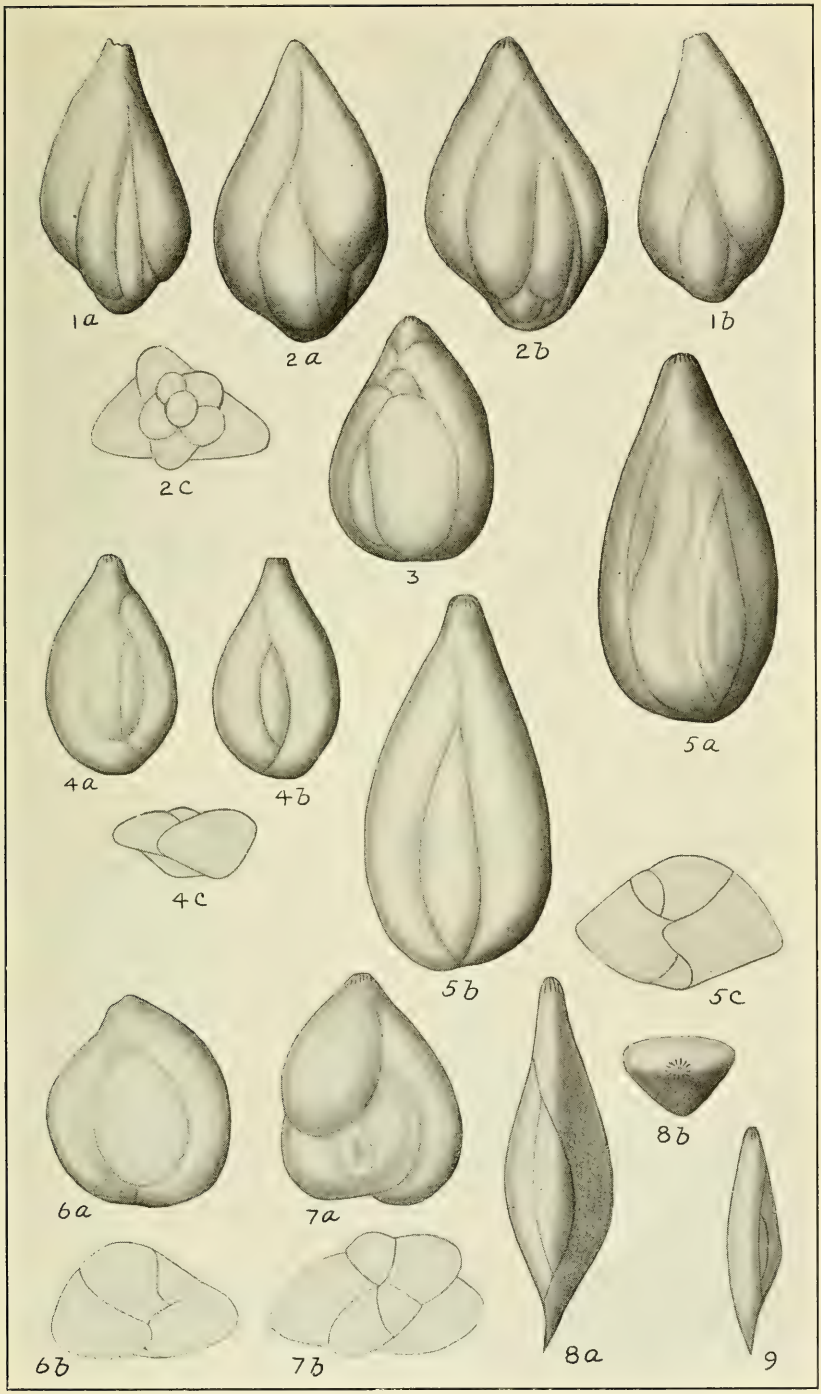
Plate 37

Figs. 1, 2. *Guttulina sadoensis* (Cushman and Ozawa). × 45. Upper Pliocene, Sawane, Island of Sado, Japan. *a*, *b*, side views; *c*, basal view.

3–5. *Guttulina* (*Sigmoidina*) *pacifica* (Cushman and Ozawa). × 35. *Albatross* D5318, Philippines. *a*, *b*, side views; *c*, basal view.

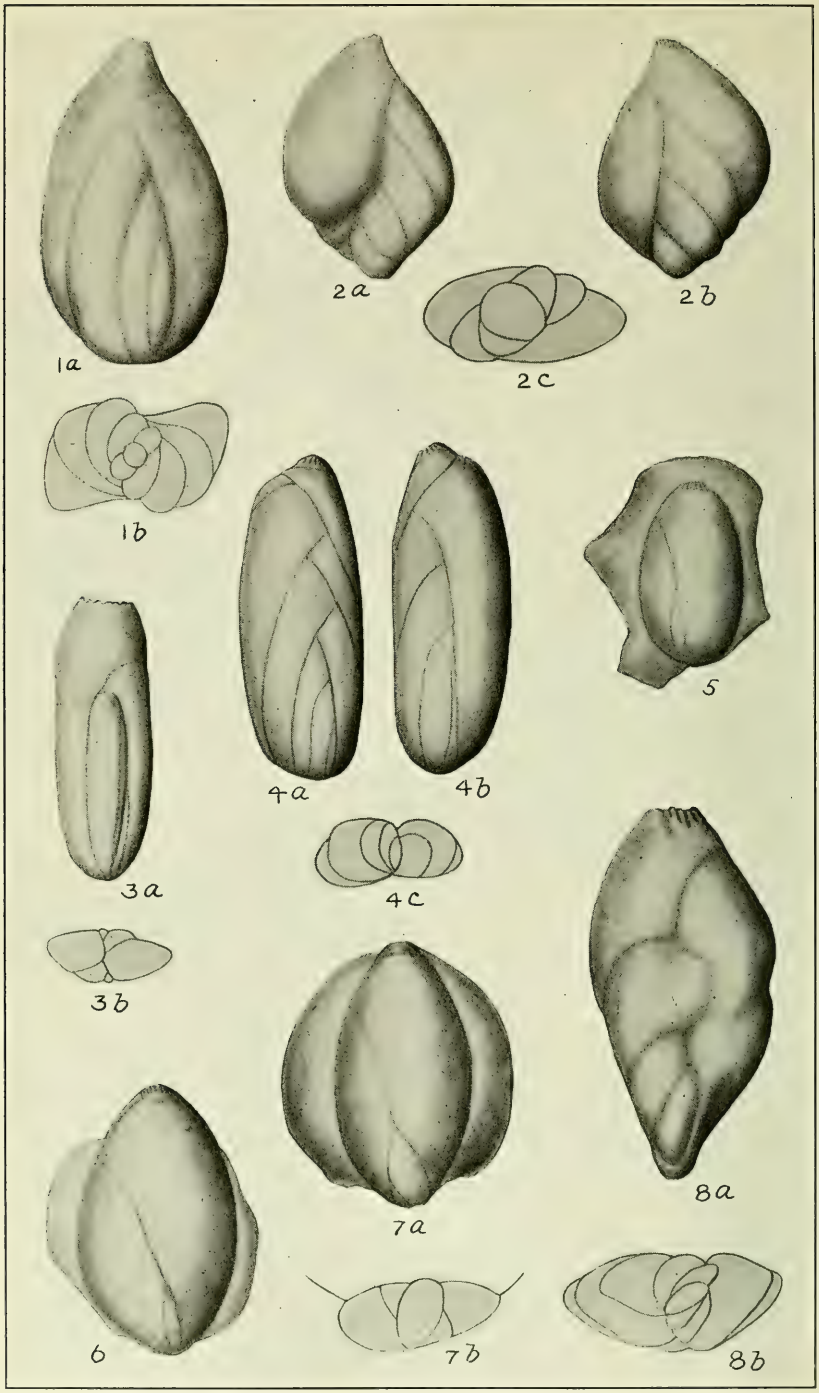
6, 7. *Guttulina* (*Sigmoidina*) *silvestrii* Cushman and Ozawa. 6, Miocene, Janjukian, Filter quarry, Batesford, Victoria, Australia. × 35. 7, Van Dieman's Inlet, Gulf of Carpenteria, Queensland, Australia, 10 fathoms. *a*, side view; *b*, basal view.

8, 9. *Guttulina* (*Sigmoidina*) *seguenzana* (H. B. Brady). × 30. (After H. B. Brady.) Recent, off Ki Islands, Pacific.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 182.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 183.

Plate 38

Figs. 1. *Sigmomorphina sawanensis* (Cushman and Ozawa). × 45. Upper Pliocene, Natsukawa, Province of Echigo, Japan. *a*, side view; *b*, basal view.

2. *Sigmomorphina vaughani* Cushman and Ozawa. × 35. Eocene, Cooper marl, Cooper River, S. C. *a*, *b*, side views; *c*, basal view.

3. *Sigmomorphina williamsoni* (Terquem). × 45. Recent, coast of Belgium. *a*, side view; *b*, basal view.

4. *Sigmomorphina williamsoni* (Terquem). × 65. Recent, coast of Belgium. *a*, *b*, side views; *c*, basal view.

5–7. *Sigmomorphina concava* (Williamson). × 80. 5, Recent, coast of Belgium. 6, Recent, off island of Delos, Mediterranean, 10 fathoms. 7, Pliocene, Monte Mario, near Rome, Italy. *a*, side view; *b*, basal view.

8. *Sigmomorphina aliceae* Cushman and Ozawa. × 35. *Albatross* D4805, coast of Japan. *a*, side view; *b*, basal view.

Plate 39

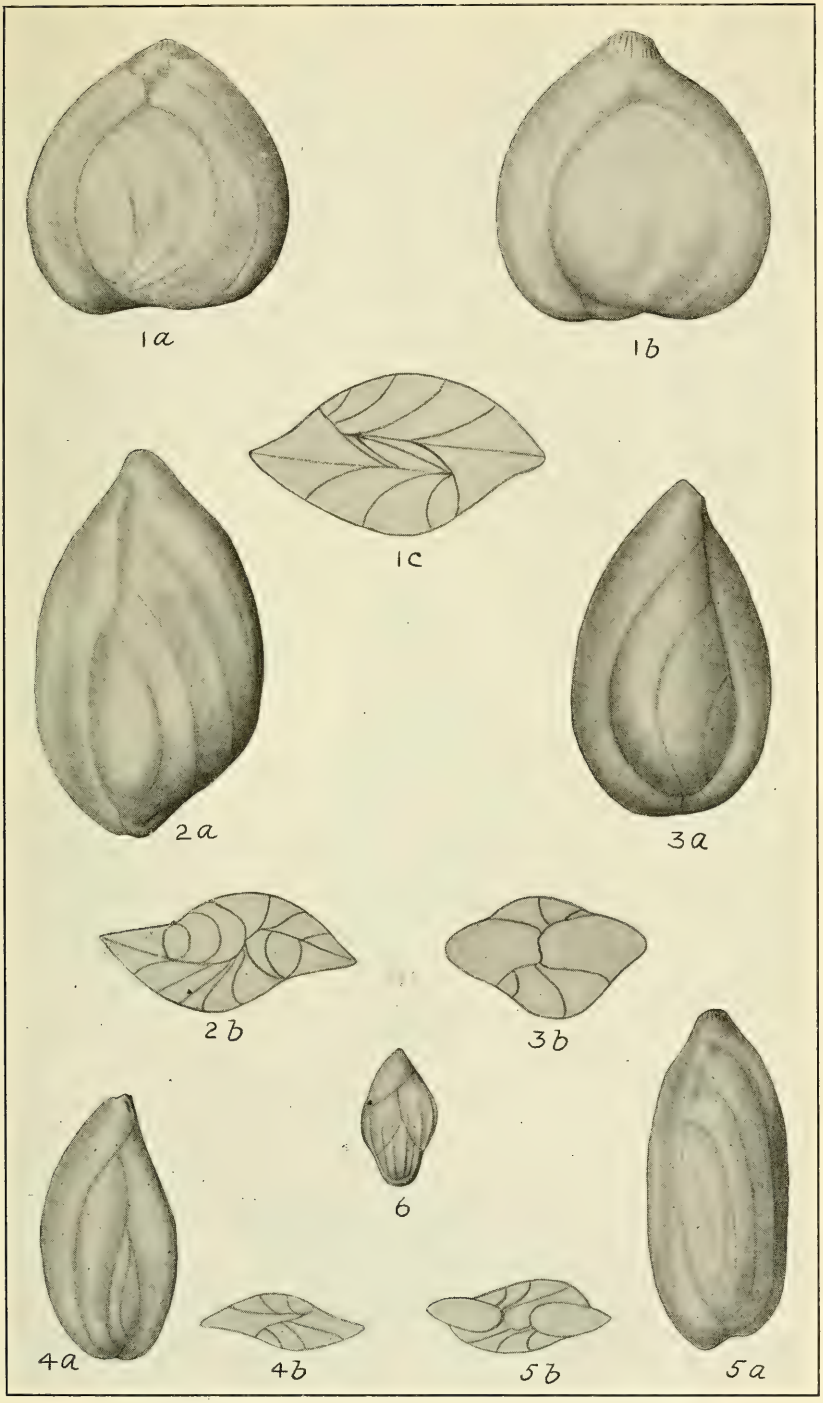
Figs. 1. *Sigmoidella elegantissima* (Parker and Jones). × 25. *Albatross* D5178. Recent, Philippines. *a*, *b* side views; *c*, basal view.

2, 5. *Sigmoidella kagaensis* Cushman and Ozawa. × 25. 2, *Albatross* D4807, off Japan. 5, off Kobama, Japan. *a*, side view; *b*, basal view.

3. *Sigmoidella plummerae* Cushman and Ozawa. × 60. Eocene, Cooks Mountain formation, Smithville, Tex. *a*, side view; *b*, basal view.

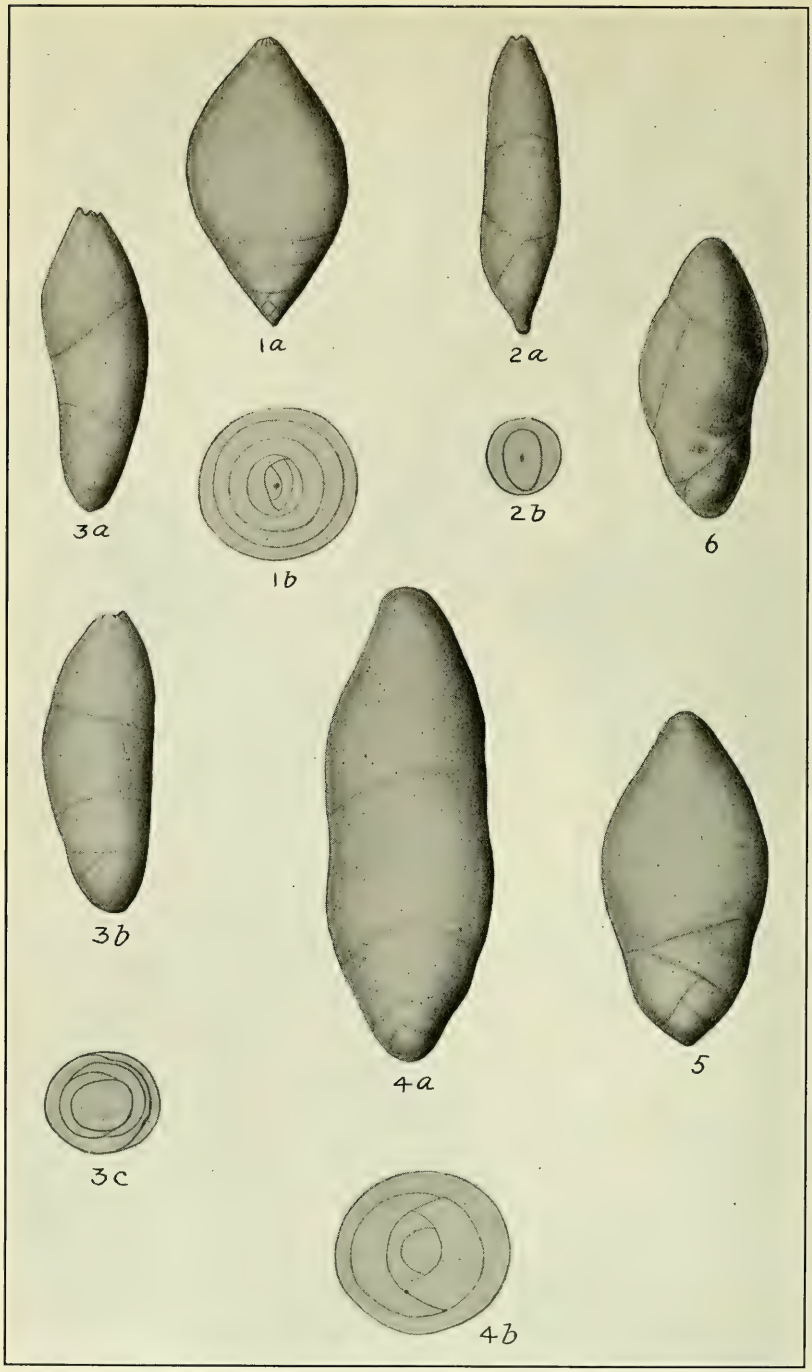
4. *Sigmoidella margaretae* Cushman and Ozawa. × 65. Recent, off Terao Miura, Japan.

6. *Pseudopolymorphina obscuricostata* (Galloway and Wissler)(?). × 75. Pleistocene, Lomita quarry, Palos Verdes Hills, Calif.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 184.



FORAMINIFERA OF THE FAMILY POLYMORPHINIDAE

FOR EXPLANATION OF PLATE SEE PAGE 185.

Plate 40

Figs. 1. *Glandulina laevigata* d'Orbigny. × 45. Miocene, Baden, Vienna Basin, Austria. *a*, side view; *b*, basal view.

2. *Glandulina reussi* Cushman and Ozawa. × 80. Oligocene, Pietzpuhl, Germany. *a*, side view; *b*, basal view.

3–5. *Glandulina dimorpha* (Bornemann). × 45. 3, Upper Oligocene, Ahnatal, near Cassel, Germany. 4, 5, Miocene, Tortonian, *Amphistegina* marl, Nussdorf, near Vienna, Austria.

6. *Guttulina yabei* Cushman and Ozawa var. *ovale* Cushman and Ozawa. × 45. Upper Pliocene, Sawane, Island of Sado, Japan.

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THE CAUDAL MOLT OF CERTAIN CORACIIFORM, COLIIFORM, AND PICIFORM BIRDS.

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In the great majority of birds, the molts of which have been studied, the order in which the rectrices are shed and replaced is centrifugal, that is, the middle pair are the first to be dropped and renewed, and the molt proceeds outward, the successive feathers being affected in turn, the outermost pair being the last to be molted. In fact, so widespread is this type of molt that it has come to be regarded as the usual condition in birds. Thus, Stone (1) found that in cases,

> * * * where there is an appreciable difference in the time of shedding the different pairs of tail feathers, it is the general rule that the outermost pair is the last to be shed, and birds are not infrequently found with the new central pair of tail feathers half grown, while the old outermost pair is still retained. * * *
>
> In *Quiscalus* and some other birds the central pair is the last to be molted, all the others having nearly completed their growth before the old middle feathers are shed.
>
> In the Woodpeckers the molt begins with the pair next to the middle and extends outward while the central pair is the last to be shed. * * *
>
> In this family the tail has a particular function, i. e., in climbing; hence the slow molt, as the birds would be at a great disadvantage if the whole tail was lost at once. The central pair of feathers are of particular importance, and the old ones are, therefore, retained until the new quills of the next pair have become sufficiently developed to temporarily take their place during their own renewal.

It may be gathered from the above quotation that there are some exceptions to the usual centrifugal sequence of rectricial ecdysis, and it is the object of the present paper to record further exceptions, and to suggest that with continued study more such cases will probably be discovered. Years ago Heinroth (12) recorded two types of tail molt—"centrifugal" and "alternating," and while some of his observations are inaccurate, still his paper is a valuable one and little deserves the neglect it has received.

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Beebe (2) seems to have been the first to record a centripetal type of tail molt (that is, one starting with the outermost pair of rectrices and proceeding inward and ending with the middle pair, in other words, just the opposite of the centrifugal type), and, indeed, it is in his work that the two terms centripetal and centrifugal were first applied to the present subject. Beebe found that some pheasants started the caudal molt with the middle pair of rectrices, while others began with the outermost pair. Later, in another paper (3) he made a hasty survey of immediately available material and found that a woodpecker (*Celeus* species) also had a centripetal tail molt. All the true pheasants (subfamily Phasianinae containing, according to Beebe, the genera *Lophophorus*, *Chalcophasis*, *Acomus*, *Lophura*, *Diardigallus*, *Lobiophasis*, *Crossoptilon*, *Gennaeus*, *Catreus*, *Pucrasia*, *Syrmaticus*, *Calophasis*, *Phasianus*, *Chrysolophus*, and *Gallus*) have a centripetal tail molt, while the Perdicinae (genera *Perdix*, *Coturnix*, *Caccabis*, *Francolinus*, *Pternistes*, etc.) have a centrifugal type. In the peafowl (*Pavo*) the molt begins with the second from the outermost pair and

> * * * there follows a regular progression inward, the outer pair being molted just before the inner ones. This sequence is invariable, both in the 10 pairs of rectrices of the cock and the 9 pairs of the peahen.

In the argus pheasants and their allies (subfamily Argusianinae containing the genera *Polyplectron*, *Chalcurus*, *Argusianus*, and *Rheinardius*) Beebe finds the molt to begin with the third from the central pair and to proceed outward and inward, the second and first pairs (inner) falling, respectively, between the fourth and the fifth and the fifth and the sixth pairs.

In his life history studies of the Panamanian toucan, *Rhamphastos brevicarinatus*, Van Tyne (4) writes that—

> * * * in their method of tail molt toucans are nearly unique among birds. Instead of molting the restrices in regular order, beginning with the central pair and progressing outward, they exactly reverse this and molt the tail from the outer toward the central feathers. Beebe * * * first described this and called it the "centripetal type" of tail molt. He also recorded this type * * * in a tropical woodpecker (*Celeus*) and in certain pheasants. I am not aware of its occurrence outside of these groups.

The fact that a centripetal type of tail molt had been found in a woodpecker and in a toucan suggested the thought that it might be fairly widely distributed among coraciine and picarian birds. Consequently, while studying the extensive series of species of these two and related orders collected in Africa by the late Edgar A. Mearns, I made a point of examing their molts in detail. Later I made a rather hasty survey of Neotropical and Asiatic groups not found in Africa to get a somewhat broader picture of the distribution of the centripetal tail molt.

I find that most woodpeckers molt their rectrices centrifugally, but a few, such as *Campethera nubica nubica*, *Dinopium javanensis intermedia*, and *Picus viridis viridis* appear to have a centripetal caudal molt. However, it should be noted that my observations are made wholly on skins in the museum, not on living birds, and that the cases of apparently centripetal ecdysis may well be all of the type described above by Stone and also by Heinroth (12). However, *Dendropicos fuscescens hemprichii* and *Thripias namaquus* have a regularly centrifugal molt. Stone's explanation, quoted above, has a teleological flavor that need not concern us in this connection, as this paper is meant merely to record certain facts and not to advance or criticize any hypotheses concerning them.

Van Tyne (4) does not mention whether *Rhamphastos brevicarinatus* is the only toucan examined by him, or if he studied other species as well and found them all to molt the tail feathers centripetally. I have gone over the toucans in the collection of the United States National Museum and found molting specimens of eight forms other than the one studied by Van Tyne. The tail molt is centripetal in *Rhamphastos tocard*, *Pteroglossus sanguineus*, *Pteroglossus inscriptus*, *Selenidera spectabilis*, and *Aulacorhynchus prasinus;* it appears to be irregular in *Rhamphastos ambiguus*, and centrifugal in *Rhamphastos erythrorhynchus.* Heinroth (12) says that the molt in the Rhamphastidae is centrifugal, but does not list the species examined.

The barbets, being among the closest relatives of the toucans, were studied with unusual interest, and the following facts were ascertained: A number of species have centrifugal tail molts, but an equal number shed their rectrices centripetally, while some appear to be irregular in their sequence. The order of rectrix renewal has no systematic significance here (or in the toucans) as it has among the pheasants, for it does not remain constant even within generic limits. The following species molt their tail feathers centrifugally: *Lybius guifsobalito guifsobalito*, *Tricholaema diadematum diadematum*, and *Tricholaema lacrymosum lacrymosum.* Those with a centripetal molt are *Tricholaema melanocephalum stigmatothorax*, *Trachyphonus darnaudii böhmi*, and *Trachyphonus darnaudii usambiro.* Two species, *Trachyphonus erythrocephalus jacksoni* and *Trachyphonus margaritatus somalicus* are irregular in this respect. It may well be that more abundant material will show these to be definite in their molting sequence and that they are comparable to such cases as Pavo and the Argusianinae in the pheasants.

The colies, being one of the best marked, systematically most isolated groups of birds, present yet another character to help set them off from all other avian families in the fact that apparently all the species of the group molt their rectrices centripetally. The

material available of *Colius indicus* and *Colius castanotus* has been very slight, but of *Colius striatus* (subspecies *striatus*, *kikuyuensis*, *erlangeri*, *hilgerti*, and *jebelensis*), of *Colius macrourus* (races *macrourus* and *pulcher*), and of *Colius leucocephalus turneri*, the material has been abundantly ample to demonstrate beyond question the centripetal sequence of their tail molt.

Among the buccos and puff birds, the only species that I have found in proper condition for this study are *Bucco dysoni* and *Bucco ruficollis ruficollis*. The former appears to be irregular, the latter centrifugal in the sequence of rectrix renewal.

Only two forms of jacamars with molting tails have been examined: *Galbula chalcothorax* and *Galbalcyrhynchus purusianus*, both of which have centrifugal molts.

I have found no evidence of a centripetal type of tail molt in either the kingfishers or the parrots, but the molting material has not been extensive. Heinroth (12) reports only a centrifugal molt in the Alcedinidae, and an irregular molt in the Psittacidae.

The kakelaars (Phoeniculidae), of which three forms have been studied (*Phoeniculus purpureus niloticus*, *Phoeniculus somalicus neglectus*, and *Scoptelus aterrimus notatus*), suggest the condition reported by Stone in the woodpeckers. Their tail molt is centrifugal beginning with the next to the middle pair and proceeding outward, the middle pair being shed after the fourth pair (counting from the middle). *Scoptelus* appears to be somewhat less definite in this matter than *Phoeniculus*.

Only one bee eater (*Melittophagus revoilii*) has been available in sufficient quantity of molting specimens. Its tail molt is irregular as far as I can make it out; that is, the condition shown in one specimen contradicts that shown in another, while a third is different from either of the first two.

The hornbills are of great interest because of a sexual difference in the tail molt. The females lose all their rectrices simultaneously, while in the males the molt is a long drawn-out process. This appears to be correlated with their peculiar nesting habits. The female is imprisoned in a hole in a tree, the entrance to which is largely plastered over preventing the passage of the bird to and from the nest. While confined in this small space all the old rectrices (and the remiges too) are dropped and new ones are grown. In the males, the tail molt is usually centrifugal, definitely and very regularly so in *Lophoceros nasutus nasutus* and in *Lophoceros erythrorhynchus erythrorhynchus;* less definite, somewhat irregular, but on the whole, centrifugal in *Lophoceros deckeni*, *Lophoceros jacksoni Bycanistes cristatus cristatus* and *Bucorvus abyssinicus*, where it starts with the middle pair of rectrices and then becomes somewhat

irregular in its progression toward the outermost pair; while in *Lophoceros melanoleucus geloensis* the molt begins simultaneously with the middle and the outermost pair.

Wetmore (5) has noted the peculiar condition found in the tail of the Malyan giant hornbill, *Rhinoplax vigil*, in which but one feather of the central pair is developed at one time.

* * * and this spike, much longer than the other rectrices, on reaching maturity, remains in position for more than a year, probably for two. Its companion, beginning its growth after the other has gained its extreme length, then equals it in size. The first feather is then molted and is gradually replaced by another, so that in the renewal of this central pair there is a continual alternation instead of the usual method by which these feathers are renewed synchronously on the right and left sides.

The facts presented in this paper form only a beginning of what might quite easily be discovered by a careful examination of the countless specimens of birds preserved in the museums of the world. Molt is an important subject in the biology of birds and it is to be hoped that more investigators will pay attention to it, either directly, or in the course of other studies. Dwight's work (6) on the molts of passerine birds, and (7) of gulls should be extended to cover all the various groups of birds of the world. Of fairly recent authors only a few have taken much pains with the subject, but those few writers, such as Stressemann (8) on *Eos*, *Merops*, *Aplornis*, *Graucalus*, and other birds of Ceram, and of Bali (11), and of Laubmann (9, 10) on kingfishers, have found enough points of interest to stimulate further researches.

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SYNONYMICAL AND DESCRIPTIVE NOTES ON PARASITIC HYMENOPTERA

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In this paper will be found notes and descriptions dealing with species referred to the families Braconidae, Chalcididae, Encyrtidae, Pteromalidae, Eulophidae, Scelionidae, and Bethylidae.

Family BRACONIDAE

OPIUS BELLUS, new species

This species is very distinct from any other represented in the collection of the United States National Museum. *Opius trimaculatus* Spinola is said by Lounsbury,[1] to infest the same host, but according to Brues and Richardson [2] that species has hyaline wings.

Female.—Length, 3.5 to 4.5 mm. Yellowish testaceous; antennae entirely, tips of mandibles, ocellar triangle, tegulae apically, and ovipositor sheaths black; hind tibiae fuscous, darker at bases and apices; hind tarsi entirely and the apical joint of fore and median tarsi black; wings uniformly strongly fuscous, veins and stigma blackish. Mesoscutum often with a large spot anteriorly and another at each lateral posterior angle, black or blackish. Antenna inserted a little above middle of eyes, 40-jointed in the type (37–40 in the series), a little longer than the body, slightly tapering from base to apex, the first flagellar joint about twice as long as thick, following joints shorter. Head smooth, polished, clothed with pale hairs; viewed from above transverse, as broad as thorax and not quite twice as broad as long, the temples about half as broad as eyes and not at all receding; face hairy, smooth, with very weak setigerous punctures; distance between the eyes below antennae distinctly greater than distance from antennae to apex of clypeus; anterior margin of clypeus somewhat produced; no opening between clypeus and mandibles; mandibles bidentate at apex with a straight ventral

[1] Agr. Journ. Cape of Good Hope, vol. 27, 1905, p. 468.
[2] Bull. Amer. Mus. Nat. Hist., vol. 32, 1913, p. 503.

margin; malar space equal to width of mandible at base; palpi long and slender, maxillary 6-jointed, labial 4-jointed. Mesoscutum smooth and polished, clothed with pale hairs, without parapsidal grooves and without median fovea or groove posteriorly; transverse groove separating mesoscutum from scutellum divided by three carinae; scutellum smooth, hairy; mesopleuron smooth, without an impression below the middle; propodeum smooth, with a very stout median keel, and densely clothed with pale hairs; wing stigma long; marginal cell extending almost to extreme apex of wing; first radial abscissa shorter than width of stigma, second one and one-half times as long as first transverse cubitus; recurrent entering first cubital; legs normal. Abdomen as long as head and thorax, ovate, entirely smooth and polished; first tergite with a short longitudinal carina on each side extending from base to near middle, the apical half of tergite perfectly smooth and without carinae; ovipositor sheaths extending about half the length of abdomen beyond its apex.

Male.—Length, 3.5 to 4 mm. Antennae 40 to 43 jointed, a little longer than in the female; tergites beyond the third more or less blackish. Otherwise like the female.

Type locality.—Balboa Heights, Panama Canal Zone.

Type.—Cat. No. 41100, U.S.N.M.

Described from 11 females (1 type) and 3 males (1 allotype) reared from *Anastrepha fraterculus* Wiedemann by James Zetek and I. Molino at three different localities in the Panama Canal Zone, as follows: Balboa Heights, August, 1926 (Z–2654); Ancon, November, 1927 (Z–2911 and Z–2913); and Barro Colorado Island, November, 1927 (Z–2909).

OPIUS LECTOIDES, new species

In the writer's published key to species of North American *Opius*[3] this runs straight to couplet 22, but is distinguished at once from *fuscipennis* Gahan by the shorter ovipositor and partly black thorax, while it differs from *canaliculatus* Gahan by its darker color, more strongly infuscated middle portion of forewing, and slightly differently sculptured first tergite, and by the fact that there are only three distinct longitudinal carinae in the groove between the mesoscutum and scutellum instead of five as in *canaliculatus*. It is also very similar to *lectus* Gahan,[4] differing only in that the ovipositor is shorter and the groove at base of the scutellum has fewer foveae.

Female.—Length, 2.4 mm. Head, scape, mandibles, most of the prothorax, mesoscutum, scutellum, axillae, a spot each on mesopleuron below base of wing, and abdomen dark reddish testaceous; palpi and legs, including all coxae, somewhat paler testaceous; an-

[3] Proc. U. S. Nat. Mus., 1915, vol. 49, p. 69.
[4] Proc. Ent. Soc. Wash., vol. 21, 1919, p. 167.

tennal flagellum, eyes, sides of pronotum for the most part, mesopleura except as noted, mesosternum, metathorax, propodeum, and ovipositor sheaths black; forewings from base to near apex of stigma weakly infuscated, the rest hyaline. The vertex and occiput are sometimes blackish and the abdomen frequently stained with piceus. Antennae inserted a little above middle of eyes, 29-jointed in the type (29–31 jointed in the series of paratypes), nearly as long as the body, slightly tapering, the first flagellar joint about twice as long as broad, following joints approximately one and one-half times as long as broad; head smooth, polished, clothed with pale hairs; viewed from above, strongly transverse, the temples about half as broad as the eyes and receding from the eye margins; a line between the eyes below antennae distinctly longer than a line from base of antennae to apex of clypeus; the setigerous punctures of face very weak; malar space slightly shorter than the width of mandibles at base; opening between clypeus and mandibles large; mesoscutum polished, with an elongate median longitudinal groove or slit on the posterior half, the parapsidal grooves deeply impressed at the anterior lateral angles, entirely effaced for nearly two-thirds the length of mesoscutum; groove separating scutellum and mesoscutum deep and divided into four foveae by three distinct carinae; scutellum smooth; mesopleura smooth, with a broad and strongly rugose impression below the middle; propodeum coarsely rugose and with a more or less distinct irregular transverse carina a little nearer base than apex; forewing with the first abscissa of radius shorter than the width of stigma; second abscissa of radius distinctly longer than first intercubitus; recurrent vein entering second cubital cell; abdomen as long as thorax, broadly oval; first tergite a little longer than broad, smooth laterally and basally but with the apical middle longitudinally rugulose; following tergites smooth; ovipositor short, its sheath about two-thirds as long as hind tarsus.

Male.—Length, 2.25 mm. Antennae 36-jointed in the type, a little longer than the body. Color generally somewhat darker than in the female. In addition to the black markings of the female, the occiput, prothorax, and abdomen, except the second tergite, are black in the male.

Type locality.—Corvallis, Oreg.

Type.—Cat. No. 41099, U.S.N.M.

Described from 10 females (1 type) and 5 males reared from *Rhagoletis symphoricarpi* Curran, the snowberry fruit fly, by F. H. Lathrop.

VIPIO MONEILEMAE, new species

Female.—Length, exclusive of ovipositor 7 mm.; length of ovipositor, about 4 mm. Head transverse, about one and one-half times as broad as long, the temples full and very nearly as broad as the

eyes; malar space equal to nearly half the height of eye; face shining, with weak setigerous punctures, and sparsely covered with long pale hairs; frons shining, divided down the middle by a shallow groove, impunctate laterad of the ocelli and narrowly along each side of the groove but with closely set setigerous punctures elsewhere, the punctate areas covered with pubescence which is much finer and shorter than the hairs on the face; vertex and temples polished but with vestiture like that on the face; antennae 45-jointed, about two-thirds as long as the body; scape about twice as long as broad, pedicel broader than long; third joint nearly twice as long as broad, the following joints subquadrate. Thorax smooth, polished, and sparsely hairy; mesonotum without trace of parapsidal grooves; transverse groove between scutellum and mesoscutum narrow and without crenulae; propodeum polished; wings extending beyond apex of abdomen, radial cell short, metacarpus equal to length of stigma and parastigma together; first abscissa of radius equal to width of stigma, second abscissa fully three times the first and very nearly equal to third abscissa; second cubital cell nearly parallel sided; recurrent nervure interstitial; legs normal, the hind tibiae not thickened and without a groove. Abdomen elongate ovate, a little longer than head and thorax, about as broad as thorax; first tergite a little longer than broad, with a broad rounded elevation in the middle which is bounded on each side by a finely crenulate furrow, the elevated portion and the lateral margins polished; second tergite with a triangular elevated smooth area medially at base and mostly smooth elsewhere, but with a broad rugulose depression on each side of the elevation; suturiform articulation strongly crenulate; a transverse groove on the third tergite and the suture between the third and fourth tergites also crenulate; remainder of abdomen polished; ovipositor a little longer than the abdomen. Head, antennae, palpi, tegulae, prosternum, mesopleura for the most part, propodeum, all legs, and the ovipositor sheaths black; prothorax except sternum, mesoscutum, scutellum, metanotum, narrow median longditudinal line on propodeum, and the entire abdomen rufotestaceous; mesosternum and metasternum more or less obscure testaceous; wings uniformly deep fuscous with a small hyaline spot at junction of recurrent vein with cubitus; stigma and veins black.

Male.—Length, 6 mm. Similar in every way to the female (the antennae are lost) except that the hind tibiae are curiously modified in that they are distinctly though not greatly thickened for nearly their whole length and on the dorsal or posterior side a broad deep groove, resembling a slit made with a knife, extends from the basal one-fourth to the apex.

Type localities.—Aguascalientes, Mexico.

Type.—Cat. No. 41098, U.S.N.M.

Described from three females (one type) received from Leith F. Hitchcock and reared by him from *Moneilema* species at Aguascalientes, Mexico, in May, 1927, and four males received from the same collector, reared from *Moneilema* species at Cedar City, Utah, in September, 1926.

Family CHALCIDIDAE

BRACHYMERIA NEPHANTIDIS, new species

Very similar to *Brachymeria thracis* (Crawford) but distinguishable at once by the nearly cylindrical flagellum, the absence of discal cilia on the base of the forewing, and the weaker sculpturing of the sixth tergite. In *thracis* the flagellum is very greatly thickened toward the apex and the discal ciliation extends to the base of the wing.

Female.—Length, 5 mm. Antennal flagellum cylindrical, very slightly narrower at base than beyond; first funicle joint slightly longer than broad, following funicle joints quadrate or subquadrate; club a little longer than two preceding funicle joints; antennal depression smooth; face with a small median area between clypeus and antennal depression smooth; remainder of head coarsely punctate, the punctation of vertex somewhat coarser than that between the antennal depression and inner eye margins; malar space longer than width of mandible at base; carina separating face from cheeks with a well-developed postorbital branch which extends to the occipital margin. Pronotum, mesoscutum, and scutellum with coarse umbilicate punctures, the interstices between punctures distinctly less than the diameter of the punctures and finely rugulose; scutellum rounded at apex, not emarginate; propodeum coarsely rugoso-reticulate, without teeth or projections. Forewing behind submarginal vein practically bare of cilia from base to about midway of submarginal vein; stigmal vein short; postmarginal nearly twice as long as stigmal. Hind coxae polished above, closely punctate beneath, without a tubercle on inner side; hind femur uniformly finely closely punctate on outer side, with about 10 teeth on the lower margin, the basal tooth not larger than some of the others, without an inner tooth near base. Abdomen as long as head and thorax, pointed ovate; first tergite perfectly smooth and polished; second nearly smooth dorsally but finely shagreened and hairy laterally; third to fifth each smooth basally but with an apical band weakly shagreened and hairy; sixth tergite finely shagreened, with about four transverse rows of very weak subobsolete punctures or pits but much less strongly pitted than in most other species; seventh tergite ventrally at apex coarsely punctate; ovipositor tip barely exserted. Tegulae, anterior and middle femora at extreme apices, their tibiae at bases and apices, and all

tarsi yellow; hind femur with a small yellow spot at extreme apex; hind tibia with a yellow spot a short distance from base and its apex yellow; wings hyaline; rest of insect black.

Male.—Length, 3 to 4 mm. Sixth tergite more transverse than in the female and with more distinct pits; otherwise like the female.

The hind tibia basad of the yellow spot is usually black but in some specimens this basal band is reddish. It is always somewhat darker than the yellow spot.

Type locality.—Ayodya patnam, India.

Type.—Cat. No. 42223, U.S.N.M.

Four females and four males received from Remachandra Rao, Coimbatore, India, and all said to have been reared from pupae of *Nephantis serinopa* Meyrich. The holotype female and another female are labeled "Ayodya patnam, S. R. coll. June 28–30–1924"; a male (allotype), "Coimbatore, S. R. coll. July 5, 1924"; two females, "Mangalore, Y. R. Rao coll. Aug. 28, 1925, and October 16, 1924"; one male "Cochin, Rao coll. Nov. 18, 1920"; and two small males, "Samalkot, Godivari district, Mch. 22, 1924, R. N. Chari coll."

Family ENCYRTIDAE

APHIDENCYRTUS APHIDIVORUS (Mayr)

Encyrtus aphidivorus Mayr, Verh. zool.-bot. Ges. Wien, vol. 25, 1875, pp. 712, 713, and 724.

Encyrtus shizoneurae Ashmead, Trans. Amer. Ent. Soc., vol. 12, 1885; Proc. p. 16 (new synonymy).

Encyrtus aphidiphagus Ashmead, U. S. Dept. Agr. Div. Ent. Bull. 14, 1887, p. 14 (new synonymy).

Encyrtus megourae Ashmead, U. S. Dept. Agr. Div. Ent. Bull. 14, 1887, p. 19 (new synonymy).

Encyrtus websteri Howard, Insect Life, vol. 2, 1890, p. 247, fig. 53 (new synonymy).

Aphidencyrtus schizoneurae (Ashmead), *aphidiphagus* (Ashmead), *megourae* (Ashmead), and *websteri* (Howard), Ashmead, Proc. U. S. Nat. Mus., vol. 22, 1900, pp. 399 and 400.

Aphidencyrtus inquisitor Girault (not Howard), Can. Ent., vol. 48, 1916, p. 342.

Aphidencyrtus aphidiphagus (Ashmead) Gahan, Proc. Ent. Soc. Wash., vol. 25, 1923, p. 187.

Aphidencyrtus inquisitor Griswold (not Howard), Ann. Ent. Soc. Amer., vol. 19, 1926, p. 331.

Aphidencyrtus inquisitor Gahan (not Howard), Proc. U. S. Nat. Mus., vol. 71, 1927, art. 4, p. 18.

Aphidencyrtus inquisitor Griswold (not Howard), Journ. Econ. Ent., vol. 20, 1927, pp. 91–93.

It was the writer's good fortune in November, 1927, to spend some time at the Naturhistorisches Museum in Vienna, Austria, studying the important collections of Chalcidoid types of G. Mayr,

Arnold Foerster, and other authors located there. Through the abundant courtesy of the custodian, Dr. F. Maidl, cotypes of a number of European species were secured for the United States National Museum collection. Among these were two cotypes of *Encyrtus aphidivorus* Mayr. These have been compared with the common encyrtid parasite of aphids in America and found to agree in every respect.

This parasite, as shown by the above list of synonyms, has been several times described in America and its identity has been somewhat obscured by reason of the fact that it has been confused by both A. A. Girault and the writer with (*Encyrtus*) *Zarhopalus inquisitor* Howard. *Encyrtus inquisitor* was described by Howard from a single female from Jacksonville, Fla. A female specimen in the National collection labeled "Jacksonville Florida" also bears the label "Type No. 2616" and the name label. This specimen was accepted by both Girault and the writer as the actual type specimen without particular reference to the description, and on the basis of a study of the alleged type the writer, in 1927, synonymized *Aphidencyrtus aphidiphagus* (Ashmead), *schizoneurae* (Ashmead), *websteri* (Howard), and *megourae* (Ashmead) with *inquisitor* Howard. Howard's description and figure of *inquisitor*, however, can not possibly apply to the alleged type as has been correctly pointed out by P. H. Timberlake.[5] Timberlake is without much doubt correct in placing *inquisitor* Howard in the genus *Zarhopalus* where Ashmead had previously placed it.

The two references by Griswold (1926 and 1927) under the name *Aphidencyrtus inquisitor* are based upon determinations made by the writer after comparison with the false type and refer to *aphidivorus* Mayr instead of *inquisitor* Howard.

COPIDOSOMA NANELLAE Silvestri

Copidosoma nanellae SILVESTRI, Boll. Lab. Zool. Agr. Portici, vol. 16, 1922, p. 296, figs. 47, 48, and 49.

Several specimens of a parasite received from K. A. Salman of the Massachusetts Agricultural College and said to have been reared from larvae of *Recurvaria thujaella* Kearfott collected in Maine during the summer of 1927 seem to agree in every respect with the description of *Copidosoma nanellae* Silvestri, a species which Silvestri records as parasitic upon *Recurvaria nanella* Hübner in Europe. *R. nanella* is known to occur in America, and the parasite appears to have been accidentally introduced with its host and to have taken to the related American species *R. thujaella*. According

[5] Univ. Calif. Pub. Tech. Bull., vol. 3, No. 2, 1924, p. 235.

to Salman the the parasite was very active in controlling this pest of arborvitae in Maine during the season of 1927.

Three specimens of the same species were received from C. R. Crosby, reared from *R. thujaella* at Ithaca, N. Y., July 2, 1925.

Family PTEROMALIDAE

HABROCYTUS PHYCIDIS Ashmead

Habrocytus phycidis Ashmead, Proc. Ent. Soc. Wash,, vol. 4, 1898, p. 157.
Habrocytus dux Girault, Can. Ent., vol. 49, 1917, pp. 181 and 182 (new synonym).

Habrocytus phycidis Ashmead was described from one specimen said to have been reared by George W. Dimmock from a larva of (*Phycis*) *Acrobasis rubrifasciella* Packard, July 25, 1892, at Canobie Lake, N. H. *Habrocytus dux* Girault was described from the same specimen and hence is a synonym. The name *phycidis* should be substituted for *dux* in Girault's key (see above citation), and the name *piercei* Crawford, which is a good species, should replace *phycidis* as treated in the key, since Girault's synonymizing of *piercei* with *phycidis* is based upon a misinterpretation of Ashmead's species.

Family EULOPHIDAE

HORISMENUS DEPRESSUS, new species

Very closely related to *H. popenoei* Ashmead but differs by having the scutellum very nearly flat, the face below antennae entirely very finely wrinkled or with only a small smooth spot between bases of antennae instead of being mostly smooth and polished, and the apical abdominal segments more strongly retracted.

Female.—Length, 1.85 mm. Occiput, vertex, and frons above transverse groove uniformly very finely reticulate-punctate; frons below the transverse groove coarsely punctate; cheeks polished; antennal pedicel very nearly as long as first funicle joint; funicle 3-jointed, the joints hairy and distinctly separated, the first about twice as long as broad, second slightly shorter than first, third a little longer than broad; club ovate, about as long as first funicle joint and scarcely thicker than the funicle joints; thorax broader between the wings than thick dorsoventrally, the scutellum flattened and in the same horizontal plane as the middle of propodeum or very nearly so, the propodeum not declivous; dorsal posterior portion of pronotum short, separated from the declivous anterior portion by a sharp margin, distinctly sculptured along anterior margin, the posterior border smooth; declivous portion of pronotum reticulate-punctate; mesonotum with fine shallow reticulation, shining; foveae at posterior end of parapsidal grooves shallow and elongate; scutellum similarly but not quite

so strongly sculptured as mesoscutum, the lateral grooves punctate; axillae finely reticulated; propodeum with the usual longitudinal depressed area on each side of the middle, these areas granularly rugulose and completely separated by a smooth median area which is of about the same width as one of the depressions; base of propodeum on either side of the middle with a transverse depressed area or large fovea which is faintly rugulose within; spiracular groove rugulose; rest of the propodeum smooth and polished except that the apical neck is more or less granularly sculptured laterally; posterior lateral angle of propodeum forming a short spinelike projection; abdomen shorter than the thorax, truncate at apex, the segments beyond the second almost wholly retracted into the second; petiole a little longer than broad and rugulose; second tergite large, polished basally, with the apical two-thirds very finely shagreened; marginal vein of forewing much longer than submarginal, the latter with two erect spines dorsally. Scape, except at apex, and legs, except their coxae, pallid; occiput and declivous anterior portion of pronotum blackish; remainder of head, pronotum posteriorly, mesoscutum and scutellum, axillae, and smooth portion of propodeum greenish black, with a strong aeneous cast; remainder of propodeum, metanotum, pleura, and coxae black or bluish black; abdomen black, faintly tinged with aeneous; wings hyaline; antennae, except basal three-fourths of scape, black, tinged with aeneous.

Male.—Length, 1.8 mm. Antennal funicle distinctly 4-jointed; first and second funicle joints subequal and each about twice as long as thick, third joint slightly shorter, fourth about as broad as long; club not twice as long as fourth funicle; segments of abdomen beyond the second wholly retracted; head above and mesonotum somewhat more strongly aeneous than in the female. Otherwise like the female and hard to distinguish from it except by the antennae and genitalia.

Type locality.—Alhambra, Calif.

Type.—Cat. No. 41101, U.S.N.M.

Described from 3 females and 15 males reared from *Bruchus pruininus* Horn by C. K. Fisher.

PLEUROTROPIS DETRIMENTOSUS, new species

Very similar to *nawaii* Ashmead but differs by having the fronto-vertex much smoother and the scutellum with a broader, well-defined, polished area down the middle.

Female.—Length, 1.6 mm. Head slightly broader than thorax; ocellar triangle distinctly rugulose; vertex laterad of lateral ocelli smooth; fronto-vertex with very faint reticulate sculpture, nearly smooth; frons on each side of antennal groove and below the trans-

verse groove distinctly finely punctate; face and cheeks smooth; occiput closely punctate; antennal flagellum with all joints thicker than the pedicel; funicle with three subquadrate and well-separated joints, the first joint a little longer than the pedicel; club ovate, a little shorter than the two preceding funicle joints combined, 3-jointed, the apical joint terminating in a short spine. Prothorax short, slightly narrower than mesothorax; declivous anterior aspect of pronotum sculptured, separated from the dorsal aspect by a delicate transverse carina, the dorsal portion perfectly smooth and shining; mesoscutum shining but distinctly reticulated, the inclosed areas along inner margin of scapulae and on posterior half of praescutum elongate and giving the appearance of delicate striations; parapsidal grooves represented posteriorly by broad shallow depressions, effaced anteriorly; scutellum with a smooth area medially extending from base to apex and occupying approximately one-third the dorsal surface, the lateral portions of scutellum distinctly reticulate-striate like the mesoscutum; propodeum polished, with three carinae medially, a delicate median one and the usual two diverging ones; marginal veins of forewing distinctly longer than submarginal, the stigmal and postmarginal short and subequal; submarginal dorsally with two long bristles; hind tibial spur long and slender, as long as the basitarsus and two-thirds of the second tarsal joint combined. Abdomen conic-ovate, very nearly as long as head and thorax together; petiole thick, slightly longer than the propodeum, very finely granularly sculptured and opaque above; second tergite equal in length to the following tergites combined, smooth at base, the apical half very finely but distinctly reticulated except a narrow band at apex which is smooth; tergites beyond the second weakly reticulated; ovipositor not exserted. General color black with a tinge of bronze; antennal flagellum metallic green; scape black; fronto-vertex slightly tinged with green; propodeum and smooth portion of second tergite bright metallic green; wings hyaline; legs greenish, all tarsi white.

Male unknown.

Type locality.—Palur, South Arcot district, India.

Type.—Cat. No. 42224, U.S.N.M.

Three females received from Ramachandra Rao are said to have been reared from cocoons of *Perisierola* species attacking *Nephantis serinopa* Meyrick. The type is from the above-named type locality, one paratype from Tudiyalur and the other from Thirupatur, Coimbatore, India.

Family SCELIONIDAE

TELENOMUS SPHINGIS Ashmead

Teleas sphingis ASHMEAD, Bull. 14, Div. Ent., U. S. Dept. Agric., 1887, p. 18.
Telenomus sphingis ASHMEAD, Bull. 45, U. S. Nat. Mus., 1893, p. 155.
Telenomus monilicornis ASHMEAD, Journ. Linn. Soc. Lond. Zool., vol. 25, 1894, p. 203 (new synonymy).

I can see no difference between the types of *sphingis* which were reared from eggs of *Phlegethontius sexta* Johanssen at Jacksonville, Fla., and the type of *monilicornis* Ashmead which is a single male collected on the island of St. Vincent.

The National collection contains in addition to the types a series of 8 specimens reared from *P. sexta* at Clarksville, Tenn., by A. C. Morgan; 31 specimens reared from eggs of the same moth at Gurabo, Porto Rico, by W. V. Tower (identified by J. C. Crawford as *T. monilicornis*); and 2 specimens reared from eggs of *P. sexta* by G. Russo in the Dominican Republic.

TELENOMUS CONNECTANS Ashmead

A single female received from G. Russo, Moca, Dominican Republic, and said to have been reared from the egg of *Phlegethontius sexta* Johanssen has been identified as *Telenomus connectans.* This appears to be the first host record for this parasite, which was originally described from the island of St. Vincent.[6]

Family BETHYLIDAE

CEPHALONOMIA TARSALIS (Ashmead)

Ateleopterus tarsalis ASHMEAD, Bull. U. S. Nat. Mus., No. 45, 1893, p. 45; female, male.
Neoscleroderma tarsale KIEFFER, in Wytsman's Gen. Ins., 1908, fasc. 76, p. 41.
Neoscleroderma tarsale KIEFFER, Das Tierreich, 1914, vol. 41, p. 270.
Cephalonomia kiefferi FOUTS, Proc. Ent. Soc. Wash., 1920, vol. 22, p. 71 (new synonymy).

J. J. Kieffer placed *Ateleopterus tarsalis* Ashmead in *Neoscleroderma* Kieffer along with *Ateleopterus virginiense* Ashmead and named the latter species as type of the genus. The types of both species have been examined by the writer and found to be not congeneric. The antennae of *tarsalis* are 12-jointed in both sexes and the species belongs in *Cephalonomia* Westwood. The antennae of *virginiense* are 13-jointed, and the genus *Neoscleroderma* will therefore stand.

[6] Proc. Zool. Soc. London, 1895, p. 792.

The types of *Cephalonomia kiefferi* Fouts agree in every way with the types of *tarsalis*.

Cephalonomia tarsalis is apparently the commonest species of Bethylidae to be found attacking stored-product insects in America. Specimens are in the collection from Saticoy and Fresno, Calif.; Wellington, Kans.; Agricultural College, Michigan; Vienna, Va.; and Washington, D. C. *Oryzaephilus surinamensis* Linneaus and *Sitophilus oryzae* Linneaus are the only species named as hosts in this material.

RHABDEPYRIS ZEAE Waterston

In February, 1929, J. J. Davis, of Purdue University, sent to the Bureau of Entomology for identification four females and three males of a bethylid which he stated were probably parasites of *Tribolium confusum* Duval and which had been taken at Lafayette, Ind., February 10, 1929, by L. F. Steiner. The writer identified these specimens at that time as "*Rhabdepyris* sp. (possibly a new species)." More recently a female of the same insect was received from T. H. Frison, of the Illinois State Laboratory of Natural History, with the information that it was reared from *Tribolium confusum* at Lafayette, Ind. Five males of the same species have also been received from the Louisiana Experiment Station, said to have been reared from stored-corn insects at Baton Rouge, La., November 12, 1928, by C. O. Hopkins. After a careful comparison of this series of specimens with Waterston's description and figures the conclusion was reached that they did not represent a new species but that they were *Rhabdepyris zeae* Waterston. Specimens were sent to Dr. James Waterston, of the British Museum, for comparison with the type, and he has confirmed the identification.

This species has not hitherto been recorded from America. It was originally described[7] from a single female specimen taken at Liverpool, England, in a shipment of maize from West Africa. The sample of grain was said to have been infested by *Calandra oryza* Linnaeus, *Tribolium castaneum* Herbst, and *Laemophlaeus ferrugineus* Stephens, and Waterston expressed the opinion that the first-named species was almost certainly the host of *Rhabdepyris zeae*. It appears probable that the species may be found to attack several of the coleopterous pests of stored corn.

[7] Repts. Grain Pests (War) Committee, Roy. Soc. Lond., No. 9, 1921, p. 27, figs. 14 and 15.

U. S. GOVERNMENT PRINTING OFFICE: 1930

THREE NEW GENERA AND FIVE NEW SPECIES OF PARASITIC CRUSTACEA

By H. F. Nierstrasz
Of Utrecht, Netherlands
and
G. A. Brender à Brandis
Of Blaricum, Netherlands

INTRODUCTION

In the course of a study of the decapod crustacea parasitized by rhizocephalids, contained in the collection of the United States National Museum, several unique forms were observed by Dr. H. Boschma, of Leiden, Netherlands. These were entrusted to the authors for determination, together with another species sent direct to us from Washington.

Puzzling as the material at first proved to be, we believe we should make it known an apparently new genus and species of Epicarid, *Faba*, new genus with *F. setosa* as the genotype; a new genus and species of parasite of *Spirontocaris* of problematical systematic affinities; *Heptalobus*, new genus with *H. paradoxus* as the genotype; and a new rhizocephalid, *Duplorbis ocarina*, parasitic on *Hemiarthus abdominalis* (Krøyer), itself a parasite of *Spirontocaris*, another case of double or secondary parasitism.

The description of a second species of *Faba*, *F. glabra*, belonging to the Bishop Museum, Honolulu, is also given here, as it is the only other known representative of this new genus.

A new species and the type of a new genus of Epicarid from China, *Apocepon pulcher*, is also described.

SYSTEMATIC DISCUSSION

FABA, new genus

Male, unknown; described from the female:

Body bean-shaped; almost wholly filled with eggs or embroyos so far as can be ascertained; near the proximal extremity a trunk

which terminates in an anchorlike head of four teeth; by means of these teeth, which are sunk into the body of the host, the animal is fastened to the latter. On the body are various lines of thickened chitin, but whether or not these have anything to do with the original segmentation can not be determined. The two known species of this genus are parasitic on Alpheidae [Crangonidae] and Hippolytidae.

The systematic position of the genus *Faba* is somewhat doubtful. The embryos of *F. glabra* certainly are those of copepods; and no doubt *Faba* belongs to the Epicaridea. Absolute certainty must, however, wait until the development of the male is known. Accepting *Faba* for the present as an Epicarid, there can be little doubt that this "simple sac filled with eggs" (Richardson, p. 497) belongs to the Tribe Cryptoniscinae. But great difficulties arise in assigning it to any particular family. The greater part of the families suggested by Bonnier contain often very few species, sometimes only one species, and these are not always thoroughly known. Hence a clear analysis of the families is often lacking. In one respect, however, Bonnier was very positive; each family is related to a different group of hosts.

Faba has very few characters; they are of no value in placing it in any of the families now known. Nor can this problem be solved by means of the host, for no family of the Cryptoniscinae is known to prey directly upon decapods, although some forms of *Danalia* (Liriopsidae) are often found associated with the former. But in these cases a rhizocephalid is the true host, the *Danalia* perforating the body-wall of the decapod in order to attach itself to the "root" of the rhizocephalid, though this is not always the case. It seems that some of these forms have ultimately become parasites of decapods. It is possible that *Faba* represents such a case, and it is true that the mode of attachment of the latter bears a striking resemblance to *Danalia*. As we have no other reason to suppose that *Faba* is, or has been, a parasite of Rhizocephala, we do not feel justified in regarding it as such. Nor do we set enough value upon the resemblance of the trunk of both forms to regard *Danalia* and *Faba* as allied. Only the study of the evolution of the female will enable us to decide the correct systematic position of *Faba*.

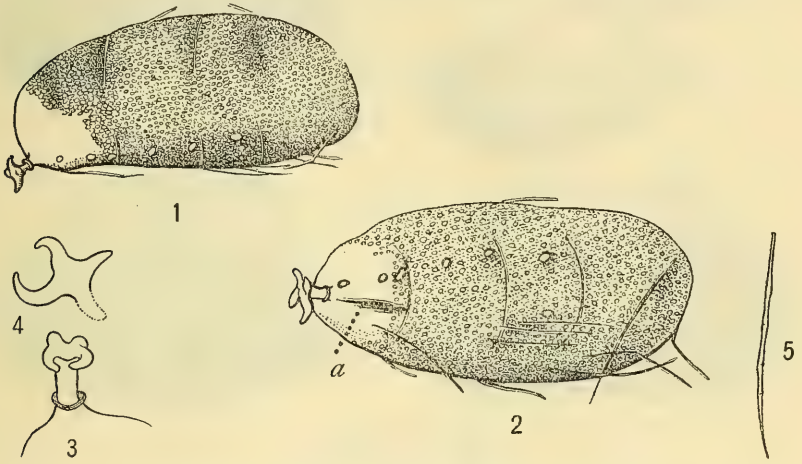
FABA SETOSA, new species

Holotype.—Cat. No. 62732, U.S.N.M. One female on *Spirontocaris bispinosa* Holmes.

Type locality.—*Albatross* Station 3170, off Central California, 38° 17′ N.; 123° 29′ W.; March 28, 1890; 167 fathoms, mud bottom.

Description.—Length, 8 mm. The body, especially the ventral side, is sparsely set with long setae. They are irregularly scattered,

generally directed backwards, and seem to be articulated. The trunk is placed quite near to the oral extremity; it terminates in two longer teeth, directed to the right side of the body, and two smaller ones directed to the left. Around the trunk, near to the body runs a thick ring of a dark brown colour. The body is transparent, with the exception of the rostral part. Only three crosslines are visible on the dorsal and ventral surfaces. On the left side of the latter a row of six tubercles occurs; on the right side only one is to be seen, but it is possible that the others are smaller, so that they can not be distinguished from the embryos, moreover the dorsal part



FIGURES 1–5.—FABA SETOSA, FEMALE, 1, FROM THE LEFT SIDE; 2, FROM THE VENTRAL SIDE; 3, TRUNK; 4, TEETH OF TRUNK; 5, SETA

on the right side is somewhat damaged (*a*, fig. 2). The tubercles may be vestiges of the thoracopods or papillae, as Caulléry has described for *Danalia* (Caulléry, p. 606).

FABA GLABRA, new species

Holotype.—One female on an Alpheid shrimp (*Crangon*). (Type in the Bishop Museum.)

Type locality.—Waikiki Reef, Honolulu. Dr. C. H. Edmonston, collector.

Description.—Length, 6 mm. The dorsal surface is somewhat damaged (*a*, figs. 6–11). The trunk is situated a little behind the rostral extremity. It is longer than the trunk of *setosa*. The teeth consist of one larger pair directed forward, and a very small pair directed backward (fig. 11). On the ventral surface, in the median part, the wall of the body is opaque and more or less folded. On the remainder of the body an extensive system of lines is to be seen, consisting of a number of crosslines and some longitudinal lines. The

number of these crosslines on the left and right sides of the body differs. The lines are not symmetrically disposed. It may be remarked that they divide the body, at least at the sides, into eight parts, situated one behind the other. Here and there, at the intersections of the longitudinal and transverse lines, small triangular areas are formed.

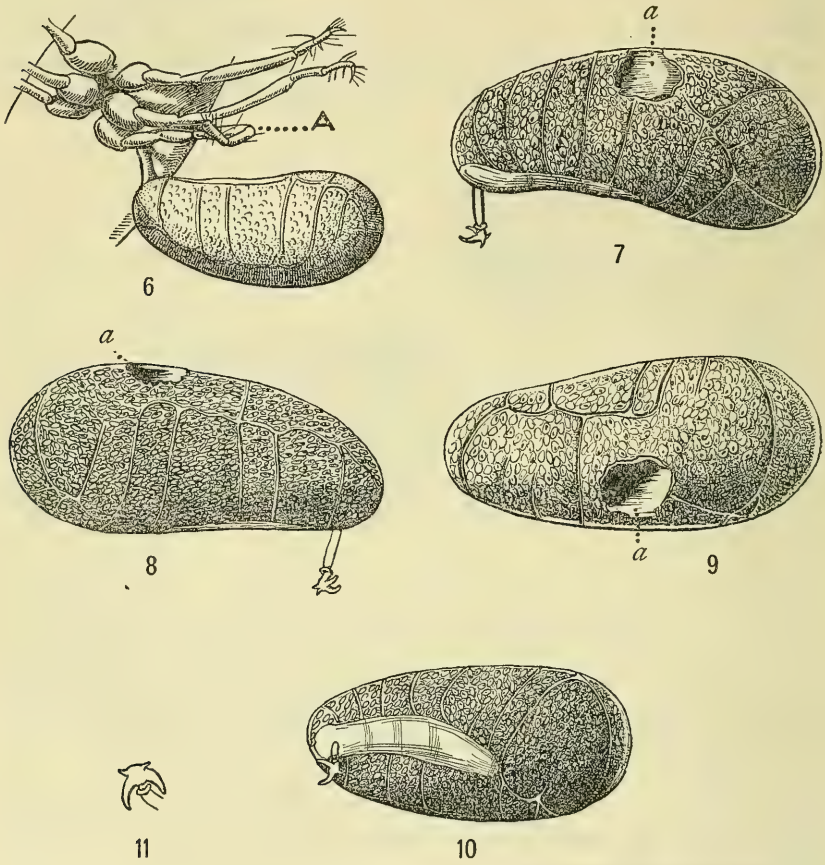


FIGURE 6–11.—FABA GLABRA, FEMALE, 6, ON HOST; *a*=THORACOPOD VIII; 7, FROM THE LEFT SIDE; 8, FROM THE RIGHT SIDE; 9, DORSAL VIEW; 10, VENTRAL SIDE; 11, EXTREMITY OF TRUNK

HEPTALOBUS, new genus

This genus is founded on the female of the species, parasitic in the branchial cavity of *Spirontocaris biunguis* Rathbun and *Spirontocaris suckleyi* (Stimpson). Although forms with seven lobes and forms with five lobes are found, we regard both as belonging not only to the same genus, but also to the same species, as both forms are found on the same host, and, except for the development of

dorsal lobes, both agree perfectly. It is therefore probable that the smaller specimens are younger and would have developed dorsal lobes in a later stage, especially as slight indications of sixth and seventh lobes are sometimes to be seen.

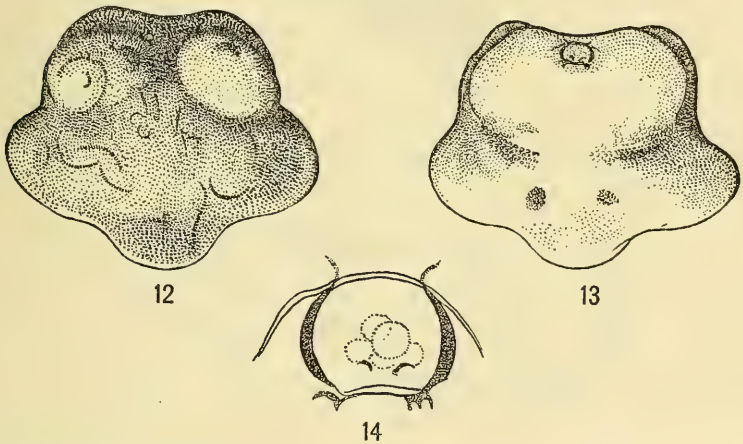
The systematic position of this organism is quite unknown. Its characters furnish no clue as to its relationships. Only a knowledge of the development and the evolution of the female will answer this question.

The largest specimen is 3½ mm. long and has a breadth of 4 mm.

HEPTALOBUS PARADOXUS, new species

Holotype.—Cat. No. 62733, U.S.N.M. A female with seven lobes on *Spirontocaris biunguis* Rathbun.

Type locality.—*Albatross* Station 3329, Bering Sea, 53° 56′ 50″ N.; 167° 08′ 15″ W., August 21, 1890, 399 fms.



FIGURES 12–14.—HEPTALOBUS PARADOXUS, FEMALE, 12, DORSAL VIEW; 13, VENTRAL SIDE; 14, MOUTH PARTS (?)

Additional material, a second female with five lobes, also on the host of the type; and four females on *Spirontocaris suckleyi* (Stimpson) each with five lobes, *Albatross* Station 2842, between Unalaska and Cook Inlet, Aleutian Islands.

The construction of the ring on the ventral surface can be studied in detail on Figure 14. It consists of two dark colored lateral clasps, which surpass rostrally and caudally a line of thickened chitin. Caudally these clasps seem to terminate in two or three teeth. The rostral line of chitin surpasses the clasps laterally. Between the ring some circles, also of thickened chitin, and two curved dark lines are visible.

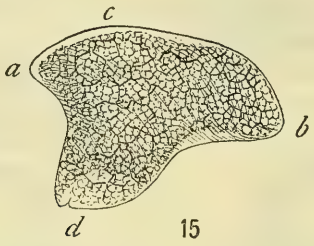
On the dorsal surface of the figured specimen various lines are found, partly indicative of the organs located beneath the surface of

the body. The proximal dorsal lobes show each a slight depression near to the frontal margin; on the left one, a circle can be traced. On the ventral surface two depressions are found on the extremities of the caudal and the lateral lobes.

With other specimens these depressions and lines are missing or differently traced, so that no great importance can be attached to them.

DUPLORBIS OCARINA, new species

Several females on *Hemiarthrus abdominalis* (Krøyer) on *Spirontocaris arcuata* Rathbun, *Albatross* Station 2842, between



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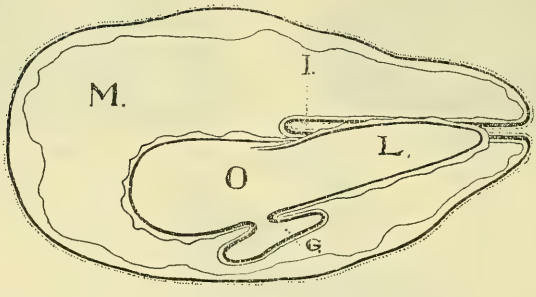

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FIGURES 15–16.—DUPLORBIS OCARINA, FEMALE, 15, LEFT SIDE. FOR *a* AND *b* SEE TEXT; FOR *c* AND *d* SEE EXPLANATION OF FIGURE 16. 16, TRANSVERSE SECTION THROUGH FEMALE CORRESPONDING WITH THE LINE *c–d*, FIGURE 15; SCHEMATIC. I, INTESTINE; L, LOBE OF OVARY; M, MARSUPIAL POUCH; O, OVARY

Unalaska and Cook Inlet, Aleutian Islands 54° 15′ N., 166° 05′ W., July 23, 1888, 72 fathoms; pebbles; of these the largest has been selected as the holotype (Cat. No. 62734 U.S.N.M.). The species is parasitic in the branchial cavity of *Hemiarthrus abdominalis* Krøyer. The male is unknown.

The body consisting of three lobes has the shape of an ocarina, a well-known musical instrument. By means of the lobe corresponding with the mouthpiece of that instrument, the animal is attached to its host. At the extremity of this lobe is a little incision corresponding to the mouth opening. The surface of the body has a

netlike appearance, caused by the eggs in the brood pouch. The largest specimen is 4 mm. long (between *a* and *b*, fig. 15).

Regarding the internal organization, the following can be said: The intestine (I) is poorly developed; only a portion of it is present, opening through the oral incision. Distally it is closed. To the left and right of the intestine lies a lobe (L) of the ovary; at some distance beyond the closed extremity of the intestine, these lobes unite to form the unpaired part of the ovary (O). At one side (the ventral side?) the ovary shows two processes (G), lined with large epithelial cells. Their inner surface is covered with a cuticle. They are in communication with the unpaired part of the ovary, being shut off from the rest of the body. The remainder of the body is occupied by the very large brood pouch.

According to van Kampen and Boschma, *Duplorbis* (p. 59) belongs to the Rhizocephala and in nearly all respects, in shape as well as in structure, our animal corresponds with that genus. Of *Duplorbis* two species are known, namely, *D. calathurae* Smith and *D. smithi* Nierstrasz and Brender à Brandis.

These three forms each have two oviducts by means of which the ripe ova pass from the ovary into the brood pouch. In *D. ocarina*, however, we have not been able to trace this communication. We might consider the two appendices (G) as oviducts, but these bodies do not appear to be in communication with the brood pouch. Notwithstanding this, we are inclined to regard them as oviducts, particularly as their internal surface is lined with a cuticle. As the brood pouch is filled with embryos, there must have been some connection with the ovary, and in our opinion, at least, through the processes referred to above. They probably close after the passage of the eggs, to reopen when the ovary is again ripe for the next periodical set of ova.

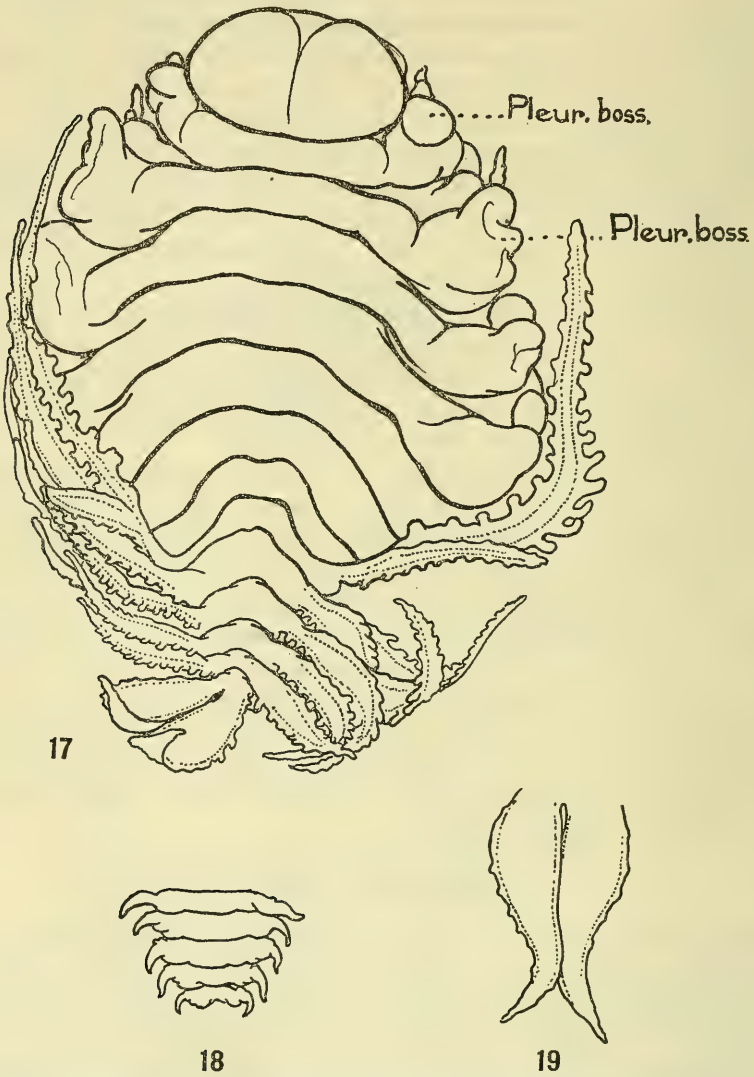
APOCEPON, new genus

For generic characters we have: *Female:* Pleural lamellae on abdominal segments I–V; lamellae elongate, and digitate (principally on caudal margin); exopods of pleopods long and digitate; endopods very short (rudimentary) and smooth; without mediodorsal bosses on peraeon or pleon. *Male:* Pleotelson markedly bifurcate; no rudiments of pleopods or uropods present; no medio-ventral bosses.

This genus is closely allied to *Trapezicepon*[1] and maybe to *Leidya*, in so far as the endopods (of the pleopods) of the latter are rudimentary, which can not be clearly made out in reading Leidy's de-

[1] Bonnier, J.: Contribution à l'étude des Epicarides. Les Bopyridae. Paris, 1900, p. 269.

scription or in studying his figures.[2] In fact, the females of *Trapezicepon* and *Apocepon* can only be separated in such minor points as the frontal lamina of the cephalon—which is large with *Trapezicepon*



FIGURES 17–19.—APOCEPON PULCHER, FEMALE, 17, DORSAL VIEW; 18, VENTRAL VIEW OF ABDOMEN WITHOUT PLEURAL LAMELLAE, EXOPODS, AND UROPODS; 19, UROPODS

and absent with *Apocepon;* the length of the exopods of the peopods—longer with *Apocepon* than with *Trapezicepon;* and the habi-

[2] Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 3, 1855, p. 150, pl. 11, figs. 26–32, quoted in H. Richardson, A Monograph on the Isopods of North America, Bull. 56, U. S. Nat. Mus., Washington, 1905, p. 511

tus—*Trapezicepon* is more thickset. With *Leidya* it differs also in the absence of a frontal lamina, whereas the uropods of the latter are much narrower.

The chief differences with these genera lie in the male: The male of *Trapezicepon* has rudimentary pleopods, whereas the male of *Leidya* has "peculiar ventral appendages" (Leidy) and long uropods. Moreover the male of *Trapezicepon* has a medio-ventral boss on the thoracic segments and the first abdominal segment.

APOCEPON PULCHER, new species

Holotype.—Cat. No. 62961, U.S.N.M. One female with male on *Philyra pisum de* Haan. Tsingtau, China; T. Urita coll.

Description of Female.—Length (without uropods) 8 mm.; breadth 5½ mm. Without eyes. Body more or less ovoid; cephalon clearly bilobed. Pleural bosses (ovarian bosses) very prominent and wrinkled, but generally not clearly set off. Coxal plates absent. Exopods of first pair of pleopods very long, reaching to the second thoracic segment. Remaining exopods on the longer side of the animal also very long, reaching to the third, fourth, fifth, and sixth segments, respectively. Those of the shorter side much shorter. Endopods linguiform. At the longer side, the pleural lamella of the first abdominal segment is about one-third or one-fourth of the length of the exopod; remaining pleural lamellae somewhat longer than the first. Uropods very broad in the middle, and with the extremity turned outward.

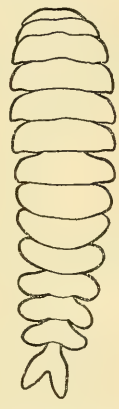


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FIGURE 20.—APOCEPON PULCHER, MALE, DORSAL VIEW

Description of Male.—Length 3½ mm. Slender, and somewhat tapering caudally. Eyes absent. Pleotelson V-shaped, and as long as the abdominal segments IV and V together.

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U. S. GOVERNMENT PRINTING OFFICE: 1930

A NEARLY COMPLETE SHELL OF THE EXTINCT TURTLE, TRACHEMYS SCULPTA

By Charles W. Gilmore

Curator of Vertebrate Paleontology, United States National Museum

INTRODUCTION

A nearly complete articulated carapace and plastron of an Emyid turtle, discovered in 1928 by Dr. J. W. Gidley in Pleistocene deposits in the vicinity of Melbourne ("Golf Course locality"), Brevard County, Florida, appears to be referable to the little known *Trachemys sculpta* Hay. In being the most perfectly preserved specimen yet found of this species, it contributes much to a better understanding of the skeletal anatomy and is, therefore worthy of the detailed description that follows.

TRACHEMYS SCULPTA Hay

Plates 1, 2, and 3

The type specimen upon which the above species was established consists of a complete nuchal bone, from the Pleistocene of Hillsboro County, Florida.

In the original description [1] Hay provisionally associated with the type specimen certain other parts of the carapace, none of which is known to pertain to the same individual. Subsequently other scattered bones of the carapace were described [2] by the same authority. It is obvious, therefore, that it is the nuchal bone alone that must be relied upon to furnish the characters which distinguish *Trachemys sculpta* from the other species of the genus.

The identification of the present specimen (Cat. No. 11839, U. S. N. M.) as belonging to *T. sculpta* rests upon the similarity in size, proportions and other features of the nuchal bone with the type. The broad rounded carina within the area of the first vertebral; the long narrow nuchal scute that is raised into a strong ridge; deeply sunken sulci and similarity in the sculpture of their dorsal surfaces these two bones are in full accord.

I am aware of the fact that some herpetologists no longer regard *Trachemys* as a valid genus but include its species under the genus

[1] Hay, O. P., Fossil Turtles of North America, Carnegie Institution of Washington, 1908, p. 351, pl. 54, figs. 4–9.

[2] Eighth Ann. Rept. Geol. Surv. of Florida, 1916, pp. 68–70, pl. 7, figs. 8–10.

Pseudemys. For the present, however, I shall follow Hay, who recognizes no less than nine extinct species all referred to *Trachemys*. Five of these, *T. euglypha* (Leidy), *T. sculpta* Hay, *T. jarmani* Hay, *T. nuchocarinata* Hay, and *T. delicata* Hay were founded upon specimens from Florida. All except *T. delicata* a supposed Pliocene species are from the Pleistocene. *T. bisornata* originally described from the Pleistocene of Texas has also been recognized [3] among Florida materials.

While there is reason to question the validity of some of these species, as most of them were founded on fragmentary specimens, more abundant and better preserved materials are necessary before a revision can be attempted.

Specimen (Cat. No. 11839, U. S. N. M.) here identified as *Trachemys sculpta* Hay is a nearly complete uncrushed shell, lacking the third and eleventh peripherals from the left side, and the eighth and tenth from the right side; neural seven and eight, and the pygal. The plastron lacks the epi-ento-and xiphiplastra.

The carapace is strongly arched in all directions. Viewed from above it is subovate in outline, broad in front, obtusely pointed behind. The median anterior border shallowly concave. In a straight line its greatest length is about 280 mm., the greatest transverse diameter at mid length being about 230 mm. In elevation this specimen is relatively greater than any of the living species of *Pseudemys* in the National collections; its maximum height being 137 mm. Along the center of the carapace, within the areas of the vertebral scutes the surface is somewhat swollen above the general contour of the shell, culminating within vertebrals three and four in obtusely rounded keels that are interrupted by the vertebral sulci separating these dorsal scutes. The margin of the carapace behind the inguinal notches is thin and comes to an acute edge that is shallowly scalloped. The anterior margins are obtusely rounded except at the center which is also acute. The sulci are everywhere deeply impressed.

The entire dorsal surface is beautifully and ornately sculptured with grooves, ridges and low pustular elevations. The areas within the vertebral scutes are smoothest, but here too some sculpture is present in the form of faint ridges and grooves that in general radiate from the central region of each scute. On the costal bones traversed by the intercostal sulci the sculpturing is much less pronounced than on the others. The costals are traversed by grooves and ridges that generally run parallel with the length of the animal. Many of the ridges are broken up at varying intervals, thus forming elevations of various sizes. The areas bordering the costo-peripheral suture is crossed at right angles by regular ridging, that forms a band extending

[3] Eighth Ann. Rept. Geol. Surv. of Florida, 1916, p. 67.

almost entirely around the circumference of the carapace. The peripheral surfaces are ornamented with coarse ridges the trend of direction varying with their position on the shell. In the anterior ones these ridges have a diagonal trend away from the center of the carapace becoming parallel with the length of the shell on the third and continuing so to the sulcus on peripheral seven. In the succeeding peripherals the area in front of the sulcus the ridging is at right angles to the free border, while posterior to the sulcus the diagonal trend continues. The under surface of the plastron is without distinctive ornamentation, only a slight roughening of the hyo- and hypoplastral areas.

The nuchal has a length of 56 mm., a width in front of 24 mm. and a maximum width of 63 mm. These same measurements of the type, taken in the same order, are 55 mm., 29 mm., and 63 mm., respectively. The anterior edge is obtuse and slightly notched on either side of the nuchal scute.

The form and proportions of the neurals are clearly shown in Figure 1. Their dimensions are given in the table.

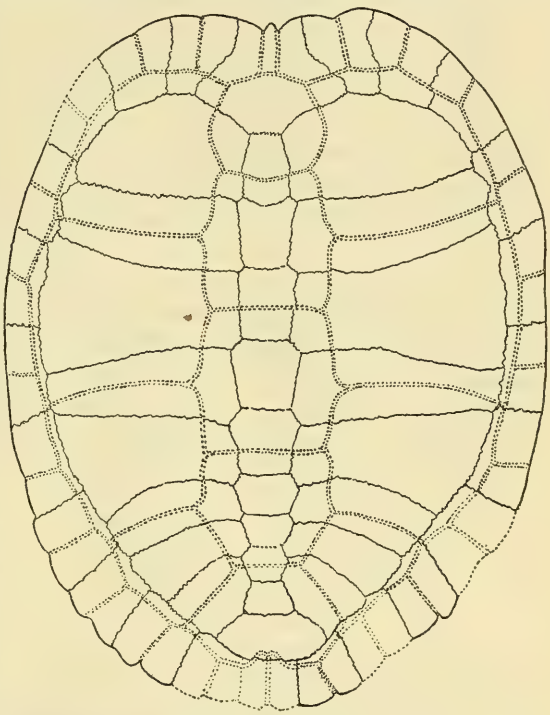


FIGURE 1.—CARAPACE OF TRACHEMYS SCULPTA HAY. CAT. NO. 11839, U.S.N.M. NEARLY ONE-THIRD NATURAL SIZE

Element	Length	Width
	Millimeters	*Millimeters*
Neural 1	34. 0	19. 5
2	26. 0	22. 0
3	30. 0	22. 7
4	27. 0	27. 7
5	28. 0	30. 0
6	18. 7	25. 0
7	15. 0	21. 0
8	15. 0	20. 0
Suprapygal 1	16. 7	20. 0
2	24. 0	45. 0

One of the outstanding structural features of *T. sculpta* seems to be the great distal expansion of costals three and five and the consequent narrowing of costals two and four. *T. hilli* (Cope) shows the costals to be fairly uniform in width as they are in most extant species of *Pseudemys*. So little is known of the costals of the other extinct species of *Trachemys* that they do not permit of comparison being made with the present specimen.

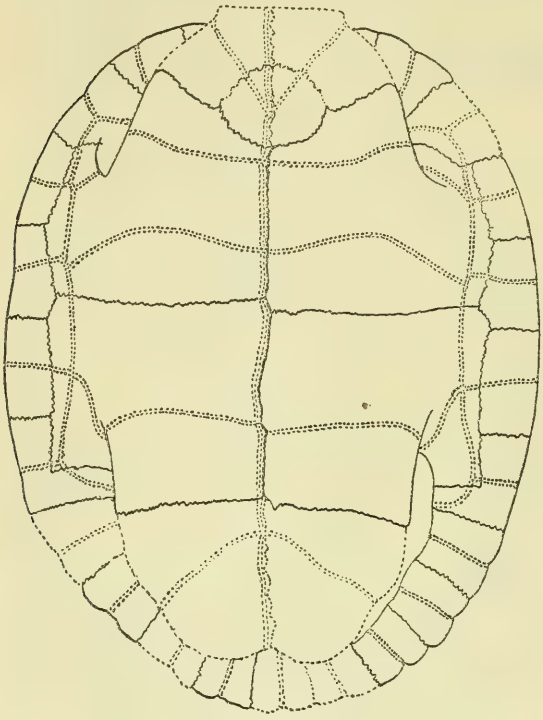


FIGURE 2.—PLASTRON OF TRACHEMYS SCULPTA HAY. CAT. NO. 11839, U.S.N.M. NEARLY ONE-THIRD NATURAL SIZE

Excepting peripheral one which presents an acute free border the others are obtuse and only slightly everted. Over the bridge an obtuse keel intervenes between the upper and lower portions of the shell. The free borders of the posterior peripherals are acutely edged and distinctly scalloped.

The sulci are everywhere deeply impressed. The form of the various scutes may be clearly determined from Figure 1. The table gives the dimensions of the vertebrals.

The nuchal scute is long and narrow and raised into a strong ridge, that projects slightly beyond the free edge. The sulci separating the costal from the marginal scutes traverses the peripherals some distance below the costo-peripheral sutures from the nuchal to the eleventh peripheral, where it rises and crosses the midline on the posterior border of the suprapygal, a condition occasionally found in the West Indian *Pseudemys rugosa* and *P. palustrus*. In *T. hilli* (Cope) this sulcus crosses the midline below the suture on the pygal, and the sulci more nearly coincide with the costo-peripheral sutures, as they do in most specimens of *Pseudemys* that have come under my notice.

Scute	Length	Width
	Millimeters	*Millimeters*
Vertebral 1	53	48
2	55	55
3	58	59
4	53	58
5	49	65

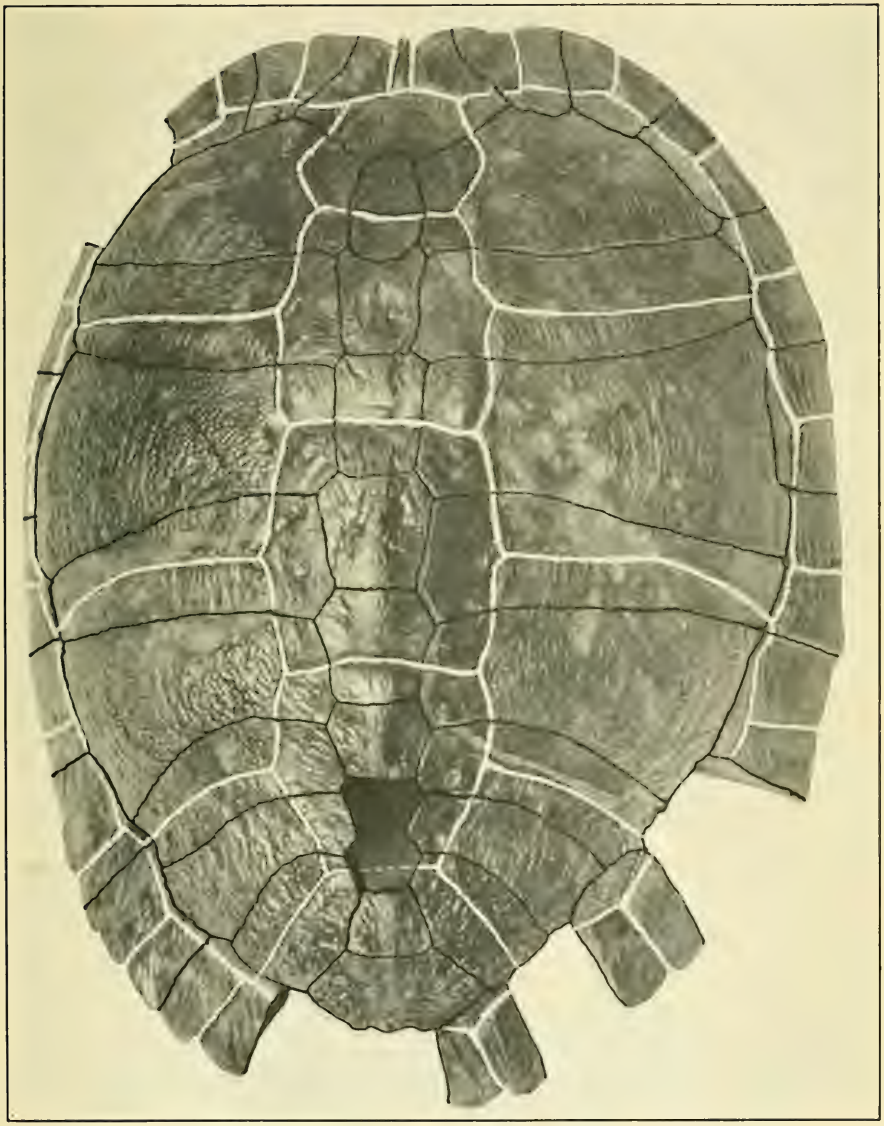
The plastron is shown in Figure 2 with the missing epi-ento-and xiphiplastral bones restored from related species. The plastron is flat, turning up slightly at the anterior end. Its surface is indistinctly sculptured. The anterior lobe has a width of 132 mm., width of posterior lobe 130 mm. The bridge is 118 mm. wide. The entoplastron has a greatest transverse diameter of 45 mm. The hyoplastra at the midline are 70 mm. long; the hypoplastra 81 mm. The pectoral scutes are 36 mm. long at the center; the abdominals 74 mm. The pectohumeral sulcus passes 4 mm. posterior to the entoplastron.

In the ornate sculpturing of the carapace, the alternate widening and narrowing of the costal plates, and the costo-marginal sulci running well below the peripheral sutures, except on the pygal, *Trachemys sculpta* has its closest resemblances in the West Indian *Pseudemys palustrus*. In height of shell, however, the extinct form greatly exceeds any of the living species of *Pseudemys* except *P. ornata*.

EXPLANATION OF PLATES

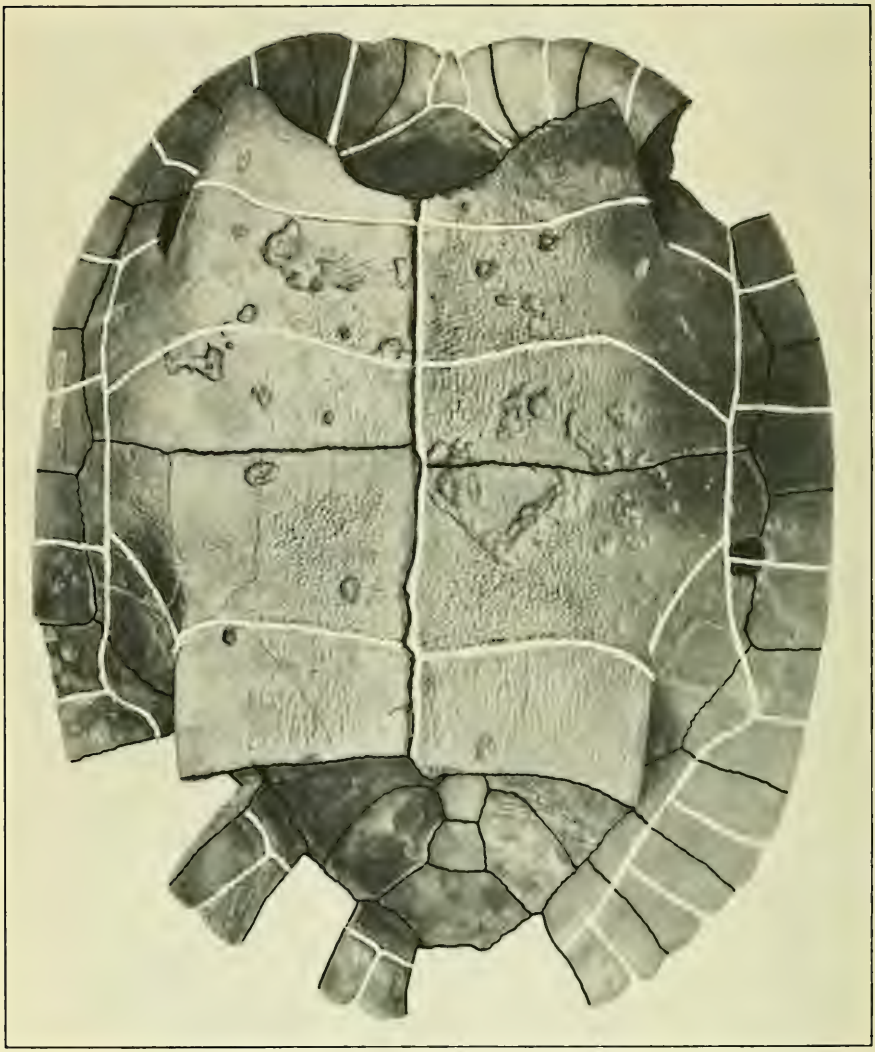
Plate 1

Trachemys sculpta Hay, Cat. No. 11839, U.S.N.M. Carapace viewed from above. Specimen from "Golf course locality," Brevard County, Florida. About one-half natural size.



TRACHEMYS SCULPTA. CARAPACE FROM ABOVE

FOR EXPLANATION OF PLATE SEE PAGE 6.



TRACHEMYS SCULPTA. PLASTRON AND CARAPACE FROM LOWER SIDE

FOR EXPLANATION OF PLATE SEE PAGE 7.

PLATE 2

Trachemys sculpta Hay, Cat. No. 11839, U.S.N.M. Plastron and carapace viewed from the lower side. Less than one-half natural size.

PLATE 3

Trachemys sculpta Hay, No. 11839, U.S.N.M. Viewed from the right side Slightly more than one-half natural size.

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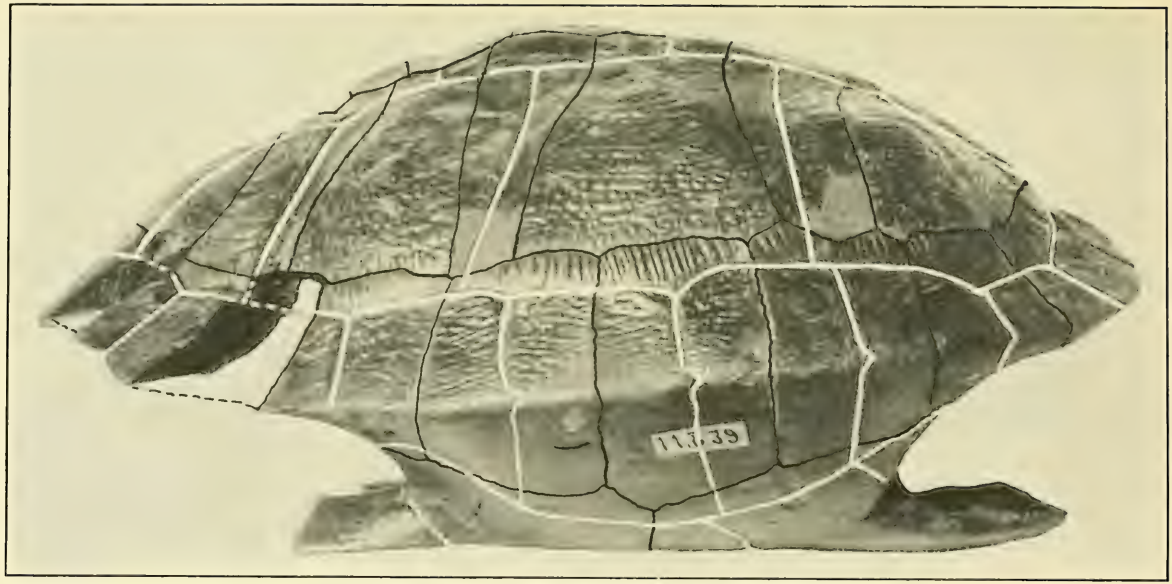


TRACHEMYS SCULPTA. FROM THE RIGHT SIDE

FOR EXPLANATION OF PLATE SEE PAGE 8.

THE HERPETOLOGICAL COLLECTIONS MADE BY DR. HUGH M. SMITH IN SIAM FROM 1923 TO 1929

By Doris M. Cochran

Assistant Curator, Division of Reptiles and Batrachians

For a number of years the United States National Museum has been the fortunate recipient of rather extensive collections from southeastern Asia. Dr. W. L. Abbott began work in this region while its fauna was still relatively unknown, the remarkable collections made by him in the islands of Malaysia as well as on the mainland itself still yielding valuable material for study purposes. Other collectors have augmented this material, and recognition of the possibilities of the zoologic study of this region has been manifested by various museums.

Most of Doctor Abbott's reptiles and amphibians were taken in Trong, Peninsular Siam. Our series of specimens from the northern part of Siam was very limited until the time when Dr. Hugh M. Smith, formerly Chief of the Bureau of Fisheries at Washington, D. C., went to Bangkok to assume control of the development of fisheries resources for the kingdom of Siam. Since 1923 we have been receiving large and varied shipments of excellently preserved biological specimens from Doctor Smith, from which some new species have already been described. A complete list of the specimens which he has sent to the United States National Museum from 1923 through 1929 has been prepared, and it is hoped that new locality records will stimulate further work by various collectors in regions only partly explored at the present time. The letter S preceding a bracketed number indicates the collector's number given to the specimen by Doctor Smith in the field. Original references are given to species described since 1912, the date of Boulenger's "Fauna of the Malay Peninsula."

No. 2834.—Proceedings U. S. National Museum, Vol. 77, Art. 11.
94383—30——1

AMPHIBIA

SALIENTIA

OXYDOZYGA LIMA (Tschudi)

U.S.N.M.		
67274	Bandon	Sept. 17, 1923.
67277, juvenal	Tale Noi	Oct. 8, 1923.
67305–6	Sikut River, Ban Pan	Nov. 25, 1923.
67307	Pasak River	Dec. 10, 1923.
67311–3	Lem Sing	Jan. 12, 1924.
70040 (S2245)	Bangkok	Nov. 7, 1925.
70136–8	Nong Mong, Krabin	Aug. 4–Sept. 1, 1925.
70186	Lam Tong Lang	July, 1925.
70379–80	Korat	Aug. 7, 1924.
72200–5	Raheng	Oct. 17, 1926.
72249 (S2828)	Nakon Sawan	Oct. 12, 1926.
72267–8	Bangson, near Chumporn	October, 1926 (R. Havmöller, collector).
75475–8 (S3513 part)	Nong Ri, Nakon Nayok	June 1, 1927.
75629	Srakeo, near Krabin	May 10, 1928.
75650–2 (S3693–5)	Bangkok	Apr. 25, 1928.
76016	Tadi Stream, Nakon Sritamarat.	July 7, 1928.
76861–3	Chombong	Nov. 29, 1928.

[Called "kiet"—the noise made by it.—H. M. S.]

OXYDOZYGA MARTENSII (Peters)

U.S.N.M.		
67299	Sikut River	Nov. 15, 1923.
70075–8	Bangkok	Aug. 8, 1925.
70131–3	Ban Sadet	May 30, 1925.
70181	Pak Jong	May 16, 1925.
70187–8	Lam Tong Lang	July, 1925.
72115	Bangkok	Aug. 5, 1926.
72196–9	Raheng	Oct. 17, 1926.
72675–6	Siam	[Label lost.—H. M. S.]
72677–9	Nong Khor	Feb. 7, 1927.
75611	Prachin	June 6, 1928.
76015	Tadi Stream, Nakon Sritamarat.	July 7, 1928.
76831 (S4058)	Kao Seming	Oct. 17, 1928.
76860	Chombong	Nov. 29, 1928.

No. 72115 was taken from the stomach of a snake, U.S.N.M. No. 72072, *Natrix subminiata*.

RANA ERYTHRAEA (Schlegel)

U.S.N.M.		
67243–5	Bangpakong River	July 2, 1923.
67254	Nontaburi	Sept. 2, 1923.
67278–9	Tale Noi	Oct. 8, 1923.
67469 (S558)	Koh Si Koh Ha, Tale Sap	Oct. 7, 1923.
67470 (S639)	Nakon River	Oct. 19, 1923.

U.S.N.M.		
70051–73 (S2036, S2041, S2114).	Bangkok	July 30–Sept. 23, 1925.
72100–111 (S2893)	do	June 11, 1926.
72182	Tale Noi	Oct. 8, 1923.
72266, juvenal	Bangson, near Chumporn	October, 1926 (R. Havmöller).
72661, juvenal	Nong Khor	Feb. 7, 1927
75601–6 (S3773–8)	Bangpli, Samrong Canal	June 2, 1928.
75658–60 (S3738–9, S3794).	Bangkok	May 18–June 19, 1928.
76009–10	Tadi Stream, Nakon Sritamarat.	July 7, 1928.
76081–2 (S3889–90)	Ban Lem Ngao	July 15, 1928.

The young specimen, 72661, from Nong Khor has a narrower tibia and shorter webs than the other specimens listed here. The specimen from Bangson, 72266, can not be positively identified because of its poor preservation and its small size.

RANA ALTICOLA Boulenger

U.S.N.M.		
72261	S. E. of Tung Song	October, 1926.

This species is represented by 19 tadpoles collected by R. Havmöller in a waterfall stream two hours' journey southeast of Tung Song. The tadpole with the light circle on the tail, its black color, and its large size is not to be mistaken.

RANA RUGULOSA Wiegmann

This common species of frog has been collected in various regions by Dr. Hugh M. Smith, as in Bangkok, Nong Khor, Nong Mong, Paknampo, Nakon Sawan, Nong Ri, Prachin, Srakeo, Kanburi, and Pichit.

RANA LIMNOCHARIS Gravenhorst

This species seems to be met with wherever there are streams or ponds. As rice fields are found throughout this region, there is every opportunity for these frogs to breed and multiply, in spite of their numerous enemies. They have been collected by Dr. Hugh M. Smith in the Bangpakong River, Rajaburi, Chao Phya, Nontaburi, Bandon, Tale Noi, Sikut River, Pasak River, Bangkok, Nong Khor, Nong Mong, Raheng, Bangson, Nong Ri, Bangpli, Prachin, Srakeo, Hua Vieng, Sao Tong, Ban Chai Montri on the Klong Tadi, Ban Ta Yai, Ban Prakien, Pichit, and on Koh Samui in the Gulf of Siam. Mr. R. Havmöller has found it at Angkor, Cambodia.

RANA CANCRIVORA Gravenhorst

U.S.N.M.		
67466–7 (S582–3)	Tale Noi village	Oct. 8, 1923.
67468 (S677)	Pak Nakara	Oct. 20, 1923.
72213–7 (S2668, 2671–4)	Lem Sing	June 11, 1926 [Padi fields].
76827 (S4047), juvenal	Kao Seming	Oct. 11, 1928.

The left foot of No. 67467 shows a peculiar malformation which I have never seen before. The three outer toes are quite normal, but the inner two toes are about equal in length and are grown together almost to the tips. At half their length they turn sharply inwards at right angles and finally point directly backwards toward the heel. The other foot of this individual is normal.

RANA NIGROVITTATA (Blyth)

U.S.N.M.		
70183	Pak Jong	May 16, 1925.
72156 (S2399)	Koh Chang	Jan. 6, 1926.
75593–600 (S3765–72)	Pran River, Peninsular Siam.	May 25, 1928.
76846 (S4136)	Doi Angka	Dec. 8, 1928.

RANA KOHCHANGAE Smith

Rana kohchangae SMITH, Journ. Nat. Hist. Soc. Siam, vol. 4, 1922, p. 223, pl. 9, fig. 5.

U.S.N.M.		
72157–60	Koh Chang	Jan. 7, 1926.

Although these are all very young frogs which have not long completed their metamorphosis, they evidently are referable to this species of large-headed frog which Dr. Malcolm Smith has recently described from Koh Chang.

RANA LATERALIS Boulenger

U.S.N.M.		
70165–72 (S2170–1, S2185–7, S2194).	Nong Mong	Aug. 20–Sept. 1, 1925.
70189–200, juvenal	Lam Tong Lang	July, 1925.
75522–3 (S3507–8)	Nong Ri, Nakon Nayok	June 1, 1927.

One of the most interesting finds was the discovery of this rather rare species at Nong Mong, Lam Tong Lang, and Nong Ri.

The diagonal glands on the back are plainly visible in fully half of the 20 specimens. The glands always run from the left shoulder toward the right hip, and are frequently emphasized by a black pigment accompanying them. The age of the individual seems to have nothing to do with the development of these diagonal glands, for some of the largest as well as some of the smallest ones are quite smooth, while some show very distinct diagonal ridges.

RANA LIMBORGII Sclater

U.S.N.M.		
67320, adult	Siam	Spring of 1924.
67321–3, juvenal	do	Do.
67324, tadpoles	do	Do.

One adult male and three very young frogs and some tadpoles belonging to this species have been collected by Dr. Hugh M. Smith in Siam, but unfortunately the exact locality record did not accompany the specimens. The adult (No. 67320) measures 33 m. in length, which is exactly the same as one of Boulenger's specimens cited in

Records of the Indian Museum,[1] This frog tallies in every point with Boulenger's summary of the species with one exception—the last three phalanges of the fourth toe are said to be free of any web, while in No. 67320 there is a narrow but distinct fringe of webbing along the toe nearly to the terminal disk.

The three young frogs (67321, 67322, and 67323) have evidently only just metamorphosed from the tadpole stage, and measure 12 mm., 10 mm., and 9 mm., respectively. In the largest of these the web on the fourth toe may be plainly seen to extend nearly to the terminal disk, although it becomes very narrow. A vial of tadpoles accompanies these frogs, probably belonging to the same species.

RANA MACRODACTYLA (Günther)

U.S.N.M.		
72262	Bangson, near Chumporn	October, 1926.

This frog was collected by Mr. R. Havmöller.

RANA MACRODON (Duméril and Bibron)

U.S.N.M.		
76064 (S3853)	Ban Kiriwong	July 10, 1928.

["Kob." Back olive, with black spots.—H. M. S.]

RANA CHALCONOTA (Schlegel)

U.S.N.M.		
76118 (S3928)	Kao Luang, Nakon Srita-marat.	July 17, 1928.

RANA LATOPALMATA Boulenger

U.S.N.M.		
76844–5 (S4134–5)	Doi Angka	Dec. 8, 1928.

This is the first Siamese record for this species.

POLYPEDATES LEUCOMYSTAX (Gravenhorst)

U.S.N.M.		
67250	Rajaburi	July 30, 1923.
67256	Nontaburi	Sept. 2, 1923.
67465 (S599)	Bandon	1922 (R. Havmöller).
70074	Bangkok	Aug. 7, 1923.
70134	Ban Sadet	May 30, 1925.
70139	Nong Mong, Krabin	Aug. 22, 1925.
70140	do	Aug. 23, 1925.
70179–80 (S1962–3)	Pak Jong	May 18, 1925.
70182	do	May 16, 1925.
70203 (tadpoles)	Bangkok	Aug. 4, 1926.
72118–31 (S2364, S2745, S2762, S2767–9, S2772–4 S2808–11, S2898).	do	May 22–Dec. 9, 1926.
72294 (S2947)	Koh Tao	Dec. 29, 1926.
72310 (S2953)	Bandon	Jan. 6, 1927.
75525–45 (S3511)	Nong Ri, Nakon Nayok	June 1, 1927.
75630–1 (S3727–8)	Srakeo, near Krabin	May 10, 1928.
75647 (S3635)	Kanburi	Apr. 16, 1928.
75661–2 (S3692, S3796)	Bangkok	Apr. 25–June 23, 1928.
76836 (S4102)	Lampang	Nov. 17, 1928.

[1] Vol. 20, 1920, p. 57.

The tadpoles 70203 are in all stages, from the very small ones up to one which already has the fore and hind legs but with the tail still unabsorbed.

PHILAUTUS NONGKHORENSIS Cochran

Philautus nongkhorensis COCHRAN, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927, p. 179.

U.S.N.M.		
70099–107	Nong Khor	Oct. 4–5, 1925.
70108 (type)	do	Oct. 5, 1925.

PHILAUTUS HANSENAE Cochran

Philautus hansenae COCHRAN, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927, p. 181.

U.S.N.M.		
70109, male adult (type)	Nong Khor	Oct. 4, 1925.
70110–6	do	Oct. 4–5, 1925.
70135, female adult	Ban Sadet	May 30, 1925.

MICROHYLA PULCHRA (Hallowell)

U.S.N.M.		
70378	Nong Mong	Aug. 20, 1925.
75459–60 (S3513 part)	Nong Ri, Nakon Nayok	June 1, 1927.

MICROHYLA BUTLERI Boulenger

U.S.N.M.		
70381	Nong Khor	Sept. 27, 1925.
72670–3	Siam	Label lost.—H. M. S.

MICROHYLA ACHATINA (Boie)

U.S.N.M.		
70050	Bangkok	Aug. 8, 1925.
70129	Nong Khor	Oct. 4, 1925.
70382–5	do	Sept. 27, 1925.
72295–306	Koh Tao	Dec. 29, 1926.
72665–7	Bangkok	Aug. 7, 1926.
72668–9	Siam	Label lost.—H. M. S.
75472–4 (S3513 part)	Nong Ri, Nakon Nayok	June 1, 1928.
75587	Pran	May 25, 1928.
76139	Koh Tao	Sept. 20, 1928.

Regarding the Koh Tao specimens, the collector notes that they are found "in jungle near water. Back light gray-green with brown markings. A black lateral streak. Very noisy at night."

MICROHYLA BERDMOREI (Blyth)

U.S.N.M.		
70092 (S2161)	Nong Khor	Oct. 1, 1925.
72132 (S2328)	Pak Jong	Nov. 15, 1925.
72663	Nong Khor	Feb. 7, 1927.
72664 (S3087)	Ronpibun	January, 1927.

The specimen from Ronpibun was collected by Mr. R. Havmöller. The Pak Jong frog on which I based my description of *Microhyla malcolmi*[2] is said by Mr. Parker to be an aberrant individual of

[2] Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927.

M. berdmorei (see H. W. Parker, The Brevicipitid Frogs of the *Genus Microhyla*."[3]

MICROHYLA ORNATA (Duméril and Bibron)

U.S.N.M.		
67238	Bangkok	June 15, 1923.
67297–8	Sikut River	Nov. 15, 1923.
70041–50	Bangkok	Aug. 8, 1925.
70079–80	do	Aug. 6, 1925.
70094–98	Nong Khor	Oct. 5, 1925.
70118–28	do	Oct. 4, 1925.
70174–5	Nong Mong	Sept. 1, 1925.
70184–5	Pak Jong	May 16–18, 1925.
70202, many tadpoles	Bangkok	Aug. 4, 1925.
70386–9	Nong Khor	Sept. 27, 1925.
72254–60	Angkor Wat, Cambodia	Jan. 12, 1926.
75461–71 (S3513 part)	Nong Ri, Nakon Nayok	June 1, 1927.
75626–8	Srakeo, near Krabin	May 10, 1928.
76014	Tadi Stream, Nakon Sritamarat.	July 7, 1928.

The numerous tadpoles from Bangkok recorded under U.S.N.M. 70202, while fairly transparent, are a dusky grayish color, and even in alcohol show evidence of a purplish iridescence beneath. This bears out Dr. Malcolm Smith's observation [4] that "the transparent tadpole of *Microhyla ornata*, as described by Stanley Flower, is by no means always colorless but can assume quite a respectable shade of gray-brown." These tadpoles are not in a very advanced stage of development, for in only a few cases do they have the hind legs, while none have the fore legs.

KALOULA PULCHRA Gray

U.S.N.M.		
67246	Bangkok	July 14, 1923.
67309	Pasak River	Dec. 10, 1923.
67325 (S31)	Bangkok	July 7, 1923. Bathroom of Hotel Royal.—H. M. S.
70032–9 (S2048–55)	do	Aug. 6, 1925.
70090 (S2159)	Nong Khor	Oct. 1, 1925.
70173 (S2103)	Nong Mong	Sept. 3, 1925.
70201 (S2246)	Bangkok	Nov. 7, 1925.
72112 (S2821)	do	Sept. 8, 1926. Dr. Hugh M. Smith's yard.
72155 (S2400)	Koh Chang	Jan. 11, 1926.
72186 (S2835)	Paknampo	Oct. 13, 1926.
75524 (S3514)	Nong Ri, Nakon Nayok	June 1, 1927.
75586 (S3764)	Pran	May 25, 1928.
75642–3 (S3630–1)	Kanburi	Apr. 15, 1928.
75663–9 (S3673, S3690, S3703–7).	Bangkok	Apr. 22–28, 1928.
76098 (S3912)	Pichit	Aug. 8, 1928.
76125 (S3940)	Bangkok	Aug. 24, 1928.

[3] Ann. Mag. Nat. Hist., ser. 10, vol. 2, November, 1928, p. 481.
[4] Journ. Nat. Hist. Soc. Siam, vol. 2, June, 1916, p. 38.

[Called "ung-arng"—the noise made by the creature during rains.—H. M. S.]

CALLUELLA GUTTULATA (Blyth)

U.S.N.M.		
70093	Nong Khor	Oct. 5, 1925.
70117	do	Do.
70176–7	Nong Mong	Aug. 30, 1925.
70178, tadpole	do	Aug. 22, 1925.

GLYPHOGLOSSUS MOLOSSUS Günther

U.S.N.M.		
72210–1 (S2500–1)	Sikiu, near Korat	Feb. 25, 1926.

BUFO MELANOSTICTUS Schneider

U.S.N.M.		
67235–6	Bangkok	June 8, 1923.
67257	Nontaburi	Sept. 2, 1923.
67463 (S557)	Koh Si Koh Ha, Tale Sap	Oct. 7, 1923.
67464 (S579)	Tale Noi village	1922 (R. Havmöller).
70087–9 (S2197–9)	Bangkok	Oct. 15, 1923.
72116–7	do	Nov. 11, 1926.
72194 (S2841)	Raheng	Oct. 12, 1926.
72218–9 (S2665–6)	Lem Sing	June 11, 1926.
72250 (S2346)	Bangkok	Dec. 16, 1925.
72251 (S2389)	Angkor, Cambodia	Jan. 12, 1926.
75588–90	Pran	May 25, 1928.
75670–8 (S3687–9, 3691, 3698–3702).	Bangkok	Apr. 25–28, 1928.
76027 (S3826)	Ban Ta Yai	July 9, 1928.
76096–7 (S3910–1)	Pichit	Aug. 8, 1928.

72116–7. These two young toads were taken from the stomach of a snake, U.S.N.M. No. 72067, *Holarchus cyclurus*.

[Siamese name "kang (=chin) kok (=hit or knock)." A popular Siamese belief is that this toad may knock a person's bare foot with its lower jaw and make a poisonous wound, like a ringworm, with its milky mucus. The wound may be treated with scraped human finger-nails applied with water.—H. M. S.]

BUFO MACROTIS Boulenger

U.S.N.M.		
75546–83 (S3509)	Nong Ri, Nakon Nayok	June 1, 1927.

BUFO PARVUS Boulenger

U.S.N.M.		
76120 (S3926)	Kao Luang, Nakon Sritamarat.	July 16, 1928.

BUFO ASPER Gravenhorst

U.S.N.M.		
72680 (S3089), juvenal	Ronpibun	Jan. 1927 (R. Havmöller).
76037 (S3831)	Ban Mor	July 9, 1928.
76065–7 (S3848–9, S3866)	Ban Kiriwong	July 10, 1928.
76078–9 (S3875–6)	Ban Hui Ta	July 12, 1928.
76119 (S3921), juvenal	Kao Luang, Nakon Sritamarat.	July 15, 1928.

APODA

ICHTHYOPHIS GLUTINOSUS Linnaeus

U.S.N.M.		
67258–60	Nontaburi	Sept. 2, 1923.
70029–31 (S1975, S2218, S2238).	Bangkok	June 9–Oct. 30, 1925.
71680	do	Dec. 16, 1925.
72132–3 (S2820, S2895)	do	Sept. 8–Dec. 7, 1926.
72293 (S2932)	Koh Tao, Gulf of Siam	Jan. 1, 1927.
75679 (S3491)	Bangkok	Aug. 4, 1927.
76138 (S3981)	Koh Tao, Gulf of Siam	Sept. 18, 1928.

The presence or absence of a yellowish lateral stripe, used as a distinguishing character to separate *glutinosus* from *monochrous*, seems to be an unsatisfactory character. In a series of three specimens, Nos. 70670–2 from Kepahiang, Sumatra, the proportions of the head and the dentition show the three to be true *monochrous;* one of them, however, has a light lateral band along the side, while the other two have no trace of such a band. Another series of four specimens, Nos. 70666–9 from Kaba Wetan, Sumatra, are *monochrous* without any lateral stripe. A single specimen from North Pagi Island, near Sumatra, No. 31701, has the head proportions and the dentition of *monochrous* but has a very distinct yellow stripe down the sides. While this stripe may thus be present or absent in *monochrous*, it is constantly present in the fourteen specimens of *glutinosus* which I have examined—2 from Ceylon, Nos. 5895 and 58751, as well as the 12 from Siam listed above. The adult female, No. 70029, measures 312 mm. in length and is distended with about 50 eggs, which measure between 6 and 7 mm. in diameter. No. 76138 was found under a decaying log in deep jungle.

REPTILIA

LORICATA

CROCODYLUS SIAMENSIS Schneider

U.S.N.M.		
76089 (S3906)	Bung Borapet	Aug. 7, 1928.

[This species is common throughout Central Siam and in certain localities abundant. The place where this young was caught, Bung Borapet, formerly had more than at present. The Minister of Agriculture and the Director-General of the Royal Irrigation Department, both very familiar with this extensive lake-swamp, report large crocodiles as having been taken here in the past, and both know of a skull 1 m. long from a specimen about 7 m. long. The usual size, however, is much smaller. Four crocodile eggs from this swamp on August 8, 1928 measured 8.7 by 5.3 cm.; 8.5 by 5.4 cm.; 8.2 by 5.2

cm.; and 8.2 by 5.2 cm. They were brought to Bangkok and began to hatch August 31.—H. M. S.]

CROCODYLUS POROSUS Schneider

U.S.N.M.			
67735	Bandon (Tapi) River	Jan. 15, 1922, skull.
67736	Inland Sea	August 1923, skull.
72730–6 (S1424, S1478, S1406, S1404, S1377, S1482, S1371).	Nakon Sritamarat	Sept. 27–Oct. 8, 1926, skins.

The first two on this list were collected by Mr. R. Havmöller. The length of 67735 was 10 feet 6 inches, while 67736 measured 9 feet 8 inches. Dr. Hugh M. Smith notes that they were literal "man-eaters."

[Bung Sifai, southwest of Pichit, Central Siam, visited August 10, 1928. The swamp, about 4,000 rai in area (1 rai = 1,600 square meters) was said to have 1,000 crocodiles less numerous than 20 years ago, as the extension of lotus growing in this swamp drives the crocodiles to other bungs where there is no cultivation. No crocodiles are killed here.—H. M. S.]

SAURIA

GONATODES SIAMENSIS Smith

Gonatodes siamensis SMITH, Sarawak Mus. Journ., vol. 3, pt. 1, no. 8, 1925, p. 21.

U.S.N.M.		
70250	Ban Sadet	May 30, 1925.
76142–4	Koh Tao	Sept. 18, 1928.

PHYLLODACTYLUS SIAMENSIS Boulenger

U.S.N.M.		
76145	Koh Tao	Sept. 18, 1928.

HEMIDACTYLUS FRENATUS Duméril and Bibron

U.S.N.M.		
67262	Nontaburi	Sept. 2, 1923.
70274, juvenal	Siam	1925.
72269 (S2943)	Koh Tao, Gulf of Siam	Jan. 1, 1927.
72311–3 (S2950–2)	Bandon	Jan. 6, 1927.
72682	Bangkok	Jan. 21, 1927.
76007	Nakon Sritamarat	July 4, 1928.
76024 (S3824)	Ban Ta Yai	July 8, 1928.
76095 (S3938)	Pichit	Aug. 8, 1928.
76140	Koh Tao	Sept. 18, 1928.
76840 (S4116)	Chiengmai	Nov. 28, 1928.

COSYMBOTUS PLATYURUS (Schneider)

U.S.N.M.		
67253	Nontaburi	Aug. 20, 1923.
67261	Nontaburi	Sept. 2, 1923.
72181	Tale Noi	Oct. 8, 1923.
72683–700	Bangkok	Jan. 21, 1927.
76004–5	Nakon Sritamarat	July 4, 1928.
76088 (S3905)	Langsuen	July 24, 1928.
76834 (S4057)	Kao Seming	Oct. 17, 1928.

No. 72700 is a young lizard with two distinct heads, the extra one growing from where the right shoulder should normally be.

PTYCHOZOON HORSFIELDII (Gray)

U.S.N.M.		
76073 (S3933)	Ban Hui Ta	July 12, 1928.

["Tok tao." Very broad tail. Found in a mangosteen tree. Not common. According to local people, if this lizard goes into a house it brings good luck.—H. M. S.]

GEKKO GECKO (Linnaeus)

U.S.N.M.		
67310	Pasak River	Dec. 10, 1923.
72078–9 (S2512, S2907)	Bangkok	Mar. 13–Dec. 23, 1926.
72192 (S2551)	Rajaburi	Apr. 10, 1926.
72701 (S3124)	Pak Jong	Mar. 20, 1927.
75454 (S3515)	Nong Ri, Nakon Nayok	June 7, 1927.
76040 (S3856)	Ban Kiriwong	July 11, 1928.

PEROPUS MUTILATUS (Wiegmann)

U.S.N.M.		
72270–2 (S2944–6)	Koh Tao, Gulf of Siam	Jan. 1, 1927.
76006	Nakon Sritamarat	July 4, 1928.
76141	Koh Tao	Sept. 18, 1928.

DRACO MACULATUS Gray

U.S.N.M.		
67315–8	Koh Chang	Apr. 5, 1924.
67477–8 (S938–9)	——do	Mar. 31, 1924.
67479 (S598)	Bandon	1922 (R. Havmöller).

DRACO QUINQUEFASCIATUS Gray

U.S.N.M.		
72245 (S2748), adult male	Bangnara	July 14, 1926.

A color description by Dr. Hugh M. Smith denotes that the gular flap was green; the wings were yellow and black, with white spots in the black.

DRACO FIMBRIATUS Kuhl

U.S.N.M.		
72235 (S2748), adult female	Bangnara	July 10, 1926.
72236 (S2747), adult male	do	July 14, 1926.

The gular flaps of both lizards were red in life.

DRACO VOLANS Linnaeus

U.S.N.M.		
72237–44 (S2749–50, S2752–7)	Bangnara	July 15–21, 1926.
76059–60 (S3839, S3861)	Ban Kiriwong	July 10–11, 1928.
76104–5 (S3920, S3918)	Kao Luang, Nakon Sritamarat.	July 15, 1928.

[76059. "Pung-ka-peek." Above rich gray-green with black spots; gular flap blue-green; wings above black with orange spots, below yellow-green with black bars; belly, gray-green, post-ventral region purplish.—H. M. S.]

[76060. Back gray with pairs of black spots on middle; a black spot on nape, another on top of head; gular region pale blue-green with black spots; wings above black with orange spots, the margin gray, below yellow-green, with black bands; belly pale yellow-green, brighter on median line. Shot from coconut tree, a favorite haunt for these creatures.—H. M. S.]

DRACO MELANOPOGON Boulenger

U.S.N.M.		
76105–9 (S3918, S3917, S3919, S3922–3).	Kao Luang, Nakon Sritamarat.	July 15–16, 1928.

DRACO BLANFORDII Boulenger

U.S.N.M.		
76110–4 (S3916, S3927, S3929–31).	Kao Luang, Nakon Sritamarat.	July 15–20, 1928.

DRACO TAENIOPTERUS Günther

U.S.N.M.		
70266 (S1950)	Pak Jong	May 18, 1925.
76051–8 (S3838, S3842–3, S3863, S3868).	Ban Kiriwong	July 10–11, 1928.

[76052. "Pung-ka-peek." Like 76051. Above grayish-green, with dark green mottlings; wings above bright yellow-green with black bands, a broad maroon distal band, below yellow-green; gular flap yellow, lateral flaps bright maroon below; belly pale yellow-green.—H. M. S.]

ACANTHOSAURA ARMATA (Gray)

U.S.N.M.		
70241 (S2157)	Nong Khor	Oct. 1, 1925.
70245–7 (S1967–9)	Ban Sadet	May 28, 1925.
70256 (S2195)	Nong Mong	Aug. 27, 1925.
70260	Lam Tong Lang	July, 1925.
70269	Pak Jong	May 18, 1925.
72143 (S2544)	Nong Khor	Mar. 25, 1926.

Dr. Malcolm Smith has united *crucigera* with *armata* on the strength of a large series from Nakon Sritamarat, in which all gradations in the length of nuchal and postorbital spines could be observed. I had found the same great variation in some of Dr. W. L. Abbott's Malayan collections and had reached the conclusion that *crucigera* was not a distinct species, although I had no very large series from a single place.

CALOTES VERSICOLOR (Daudin)

Examples of this species, too numerous to be listed individually, have been taken at the following localities: Rajaburi, Nontaburi, Taluei Island, Tale Noi village, Bangkok, Nong Khor, Ban Sadet, Pak Jong, Tha Chang, Sikiu, Bangnara, Bandon, Kanburi, Nakon Sritamarat, Ban Chai Montri, and Ban Prakien.

CALOTES MYSTACEUS Duméril and Bibron

U.S.N.M.		
70267 (S1957)	Pak Jong	May 18, 1925.
72165 (S2616)	do	May 10, 1926.
72178–9 (S2814–5)	Bang Suk, near Pak Jong	Aug. 18–19, 1926.
72209 (S2505)	Sikiu, near Korat	Feb. 28, 1926.
72704 (S3125)	Pak Jong	Mar. 20, 1927.
72705 (S3126)	Tha Chang, near Pak Jong	Do.
75637–8 (S3626–7)	Kanburi	Apr. 11, 1928.
76093–4 (3908–9)	Pichit	Aug. 8, 1928.

70267. The coloration of this adult male in alcohol is as follows: A broad whitish band beginning beneath the nostril, extending and widening along the upper labials, passing across the tympanum, and ending above the shoulder, where it merges with the reddish dorsal blotches; head and throat deep blue-black above and below this white band. This specimen has a very large gular sac, which is also blue-black in color.

[76093. "Kingka." Throat blue; ear area yellow; blotches on back reddish brown.—H. M. S.]

[76094. Throat bright blue; a yellow stripe from snout to shoulder; tail black-barred.—H. M. S.]

CALOTES EMMA Gray

U.S.N.M.		
67480–2 (S944, S949, S951).	Koh Chang	Mar. 31–Apr. 3, 1924.
70251 (S2095)	Nong Mong	Aug. 22, 1925.
70268 (S1958)	Pak Jong	May 18, 1925.
72152 (S2397)	Koh Chang	Jan. 8, 1926.
76025 (S3825)	Ban Ta Yai	July 8, 1928.
76030–2 (S3827–9)	Ban Tadi	July 9, 1928.
76033–6 (S3832–5)	Ban Mor	Do.
76042–50 (S3836–7, S3841, S3858–60, S3862, S3864–5).	Ban Kiriwong	July 11, 1928.
76072 (S3874)	Ban Hui Ta	July 12, 1928.
76085	Ban Prakien	July 16, 1928.
76837–8 (S4094, S4104)	Lampang	Nov. 17–18, 1928.

Nearly as plentiful as *versicolor* in some places, this lizard is not found at Bangkok, and consequently does not appear so often in collections having their main source at the imperial city of Siam.

["Kingka." This lizard very common in Ban Mor. Small boys brought many specimens. The general color is pale green with rich

brown-red markings. 76025: Sides black, brown, and old gold. 76045: Light green with a cream-color lateral stripe and pairs of black spots above and below the stripe; these spots continued also on tail; sides rich green; throat greenish white, each scale with a velvety, black base; belly white; a rounded black spot on side of throat anterior to leg. 76047: Green with black crossbands; crossbands on tail brown; a black band through eye; top of head and lips bright green; throat dead black; entire belly and inside of thighs dusky to black. 76048: Back reddish brown with black spots that form loops on middle of back; black blotches on sides; side of head greenish yellow with two black stripes above; a black spot on side of throat; throat and entire under parts dirty white with dull black markings. 76049: Bright green with narrow dark crossbands; a gray longitudinal stripe along upper part of side; a black spot on side of neck; top of head and lips pale green; a black stripe through eye; five radiating black lines above eye; throat and breast creamy with black lines; belly dirty white. 76050: A large green form with brownish-red blotches. 76072: Very pale green with maroon markings; throat white with black lines; belly mottled brown.—H. M. S.]

LEIOLEPIS BELLIANA (Gray)

U.S.N.M.			
67471–5 (S940, S943, S945, S948, S950).	Koh Chang		Mar. 31–Apr. 1, 1924.
67476 (S1040)	Lem Sing		Jan. 13, 1924.
70261–5 (S1952–6)	Pak Jong		May 18, 1925.
72206 (S2503)	Sikiu, near Korat		Feb. 27, 1926.
72706 (S2664)	Lem Sing		June 9, 1926.
75636 (S3625)	Kanburi		Apr. 10, 1928.

VARANUS NEBULOSUS (Gray)

U.S.N.M.			
76039 (S3867)	Ban Kiriwong (Tadi Stream)		July 11, 1928.

[The specimen is a young one. This form is called "ta-kuat." It was met with daily along the mountain streams, living among bowlders.—H. M. S.]

VARANUS SALVATOR (Laurenti)

U.S.N.M.			
75710 (S3792)	Koh Tao		Dec. 27, 1926.

[Water lizard. Siamese name, "hia." Found asleep at night on Koh Tao and brought in by my men. Total length, 248.5 cm. Black with yellow bands; yellow below. Male. Stomach contained an enormous land crab swallowed whole. Intestines apparently free from parasites. Skin and skull preserved. A specimen 1.5 m. long found dead on Koh Tao beach December 29, 1926. It had deep wounds in abdominal walls and was possibly killed by an eagle.

This kind of lizard is not uncommon within the city limits of Bangkok, in large gardens where there are klongs (canals) and abundant shrubbery. Most Bangkok gardens fulfill these requirements.

The hia is quite destructive to ducks and chickens. I have met with this or related species all over central and peninsular Siam. In Nakon Sritamarat in 1923 I saw one at very close range several times that was 2.7 m. long. As seen going through the jungle, this creature had a real dinosaurlike appearance, with its long neck, small head, and long, heavy tail. One has been reported to me by a British subject long resident in Siam that was said to be 14 feet long. The usual length is under 6 feet. The eggs are highly esteemed by the Siamese, and are deemed fit for presentation to the royal household.—H. M. S.]

TAKYDROMUS SEXLINEATUS Daudin

U.S.N.M.		
70258	Lam Tong Lang	July, 1925.
72080 (S2766)	Bangkok	Aug. 5, 1926. "Rare in Bangkok."

MABUYA MULTIFASCIATA (Kuhl)

U.S.N.M.		
67314	Koh Chang	Apr. 5, 1924.
67488 (S942)	do	Mar. 31, 1924.
67489 (S722)	Nontaburi	Sept. 2, 1923.
70252–5 (S2094, S2098, S2100).	Nong Mong	Aug. 20–27, 1925.
70270, juvenal	Pak Jong	May 18, 1925.
70391–2	Nong Khor	Sept. 27, 1925.
72154, juvenal	Koh Chang	Jan. 7, 1926.
75455–6 (S3516–7)	Nong Ri, Nakon Nayok	June 10, 1927.
75700–3 (S3677–9, S3736)	Bangkok	Apr. 23–May 18, 1928.
76041 (S3855)	Ban Kiriwong	July 10, 1928.
76069–71 (S3870–2)	Ban Hui Ta	July 12, 1928.
76077	do	Do.
76092 (S3907)	Pichit	Aug. 8, 1928.

[76041. Back dark green, a reddish-brown lateral band with pale yellow spots; belly pale grass green; throat white; under side of tail bottle green.—H. M. S.]

[76069. Back brown with four or five black lines; a black lateral band with white spots; belly salmon; under side of head and tail green. Shot.—H. M. S.]

MABUYA LONGICAUDATA (Hallowell)

U.S.N.M.		
67490 (S937)	Bangkok	Mar. 28, 1924.
70229–40 (2044–5, S2056–7, S2063–4, S2071, S2079–80, S2166, S2220, S2234).	do	Aug. 4–Oct. 27, 1925.
70257 (S2010)	Lam Tong Lang	July 20, 1925.
72091–8 (S2331, S2340–3, S2451, S2597–8).	Bangkok	Nov. 9, 1925–Apr. 21, 1926.
72146 (S2542)	Nong Khor	Mar. 21, 1926.
72166 (S2615)	Pak Jong	Apr. 30, 1926.
72173 (S2891)	Tha Chang, near Pak Jong	Nov. 20, 1925.
72232–3 (S2758, S2751)	Bangnara	July 16–22, 1926.

MABUYA MACULARIA (Blyth)

U.S.N.M.		
70273	Pak Jong	May 18, 1925.
70393	do	Do.
72099 (S2344)	Bangkok	Dec. 16, 1926.
72153 (S2396)	Koh Chang	Jan. 7, 1926.
72167–9 (S2327, S2911–2)	Pak Jong	Nov. 15, 1925–Dec. 19, 1926.
72707	Nong Khor	Feb. 7, 1927.
76116 (S3925)	Kao Luang, Nakon Sritamarat.	July 16, 1928.
76832 (S4053)	Kao Seming	Oct. 13, 1928.
76841	Khun Tan Mts	Nov. 19, 1928.

LYGOSOMA ANGUINOIDES Boulenger

U.S.N.M.		
72273	Koh Tao, Gulf of Siam	Jan. 1, 1927.

A note by Dr. Hugh M. Smith regarding this lizard says that it was found "under a log in deep jungle. Back white, with lines of dark green spots; a black lateral band, general color gray-green. Only one seen. Apparently rare."

It agrees very well with Boulenger's original description, except that it has 5 upper labials instead of 6. Dr. Malcolm Smith has collected this species and has reported that some of his specimens have 5 upper labials.[5] In my specimen the pair of preanal scales are not much enlarged although the three ventral scales immediately preceding them are conspicuously widened. There are 22 scale-rows around the middle of the body. The head and body measure 46 mm., the tail (apparently complete) 43 mm.

LYGOSOMA QUADRUPES (Linnaeus)

U.S.N.M.			Scale rows at mid-body
67266	Nontaburi	Sept. 2, 1923	26
67267	do	do	24
67268	do	do	24
67269	do	do	24
67270	do	do	26
72320	Bangkok	Dec. 8, 1926	24
72321	do	do	26
75457	Nong Ri, Nakon Nayok	June, 1927	24
75458	do	do	24
75641	Kanburi	Apr. 9, 1928	24
75704	Bangkok	Dec. 17, 1927	26
75705	do	May 15, 1928	24

In this species the scale rows of the body are far from being regular, so that it is possible to get a number of different scale counts on the same individual at different places. The minimum is given here.

[5] Journ. Nat. Hist. Soc. Siam, vol. 2, 1916, p. 157.

SPHENOMORPHUS MACULATUS (Blyth)

U.S.N.M.		
67487 (S941)	Koh Chang	Mar. 31, 1924.
70243–44	Nong Khor	Sept. 22–Oct. 1, 1925.
70259	Lam Tong Lang	July, 1925.
72144–5 (S2545–6)	Nong Khor	Mar. 25, 1926.
72170 (S2614)	Koh Chang	Apr. 28, 1926.
76062–3 (S3852, S3854)	Ban Kiriwong	July 10, 1928.
76074–5	Ban Hui Ta	July 12, 1928.
76115–6 (S3924)	Kao Luang, Nakon Sritamarat.	July 16, 1928.

[76062. "Ching-len." Back and top of head brown; a black band from eye to thigh with pale yellow spots; an ill-defined pale yellow band from snout, under eye, to thigh with brownish reticulations; belly bright green-yellow, becoming pale gray-green posterior to vent; throat white; a pale stripe on each side of yellow abdomen; dorsal surface of legs brown with black and pale yellow spots; ventral surface of legs pale yellow-green; edge of eyelids pale yellow.—H. M. S.]

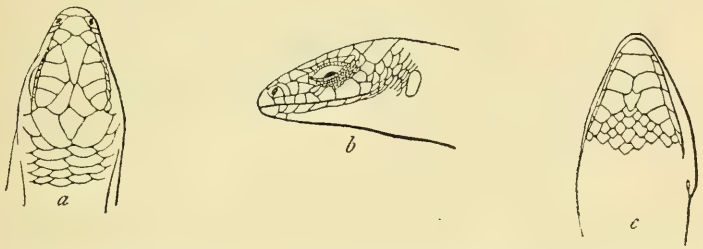


FIGURE 1.—SPHENOMORPHUS HELENAE. TYPE. U. S. NAT. MUS. NO. 67265. FROM NONTABURI, SIAM. *a*, TOP OF HEAD; *b*, PROFILE VIEW; *c*, UNDER SIDE OF HEAD

SPHENOMORPHUS HELENAE Cochran

Sphenomorphus helenae COCHRAN, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927, p. 183.

U.S.N.M.		
67265, type	Nontaburi	Sept. 2, 1923.

RIOPA BOWRINGII (Günther)

U.S.N.M.		
67264	Nontaburi	Sept. 2, 1923.
72277–81 (S2933–5, S2937–8)	Koh Tao, Gulf of Siam	Jan. 1, 1927.
72285–92	do	Dec. 31, 1926.
72708	Nong Khor	Feb. 7, 1927.
76151–9	Koh Tao, Gulf of Siam	Sept. 18, 1928.

RIOPA HUGHI (Cochran)

Sphenosoma hughi COCHRAN, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927 p. 185.

U.S.N.M.		
72274–6 (S2936, S2941 type, S2942).	Koh Tao, Gulf of Siam	Jan. 1, 1927.
76148–50	do	Sept. 18, 1928.

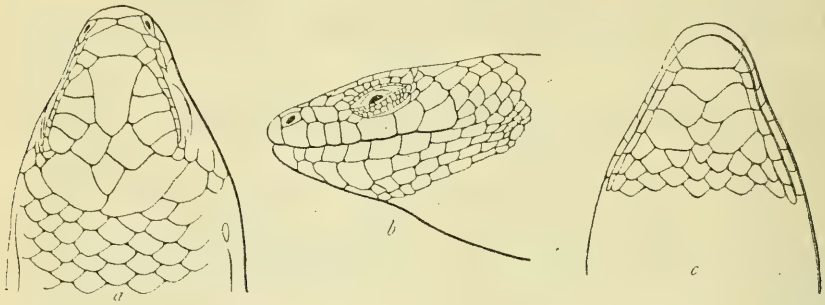


FIGURE 2.—RIOPA HUGHI. TYPE. U. S. NAT. MUS. NO. 72275. FROM KOH TAO, GULF OF SIAM. *a*, TOP OF HEAD; *b*, PROFILE; *c*, UNDER SIDE OF HEAD

RIOPA HERBERTI (Smith)

Lygosoma herberti SMITH, Journ. Nat. Hist. Soc., Siam, vol. 2, 1918, p. 45.

U.S.N.M.		
76076	Ban Hui ta	July 12, 1928.

LEIOLOPISMA EUNICE Cochran

Leiolopisma eunice COCHRAN, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927, p. 187.

U.S.N.M.		
70271–2, juvenal	Pak Jong	May 18, 1925.
72180 (S2816), type	Bang Suk, near Pak Jong	Aug. 19, 1926.
76851–7	Doi Angka, 7,000 feet	Dec. 4, 1928.

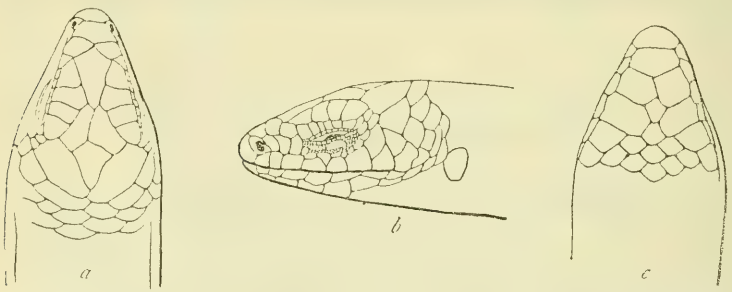


FIGURE 3.—LEIOLOPISMA EUNICE. TYPE. U. S. NAT. MUS. NO. 72180. FROM BANG SUK, NEAR PAK JONG, SIAM. *a*, TOP OF HEAD; *b*, PROFILE VIEW; *c*, UNDER SIDE OF HEAD

LEIOLOPISMA PRANENSIS, new species

Diagnosis.—Limbs well developed; ear opening distinct; lower eyelid with an undivided, transparent disk; no supranasals; four

median dorsal rows enlarged; prefrontals forming a long median suture; hind limb reaching three-fifths to four-fifths the distance to axilla, reaching wrist or elbow; 21 keeled subdigital lamellae on the fourth toe.

Type.—U.S.N.M. No. 75591, from Pran, Peninsular Siam, collected on May 25, 1928, by Dr. Hugh M. Smith.

Description of the type.—Distance between the end of snout and forelimb about one and one-third times in distance between axilla and groin; limbs well developed, pentadactyle; hind limb barely reaching wrist when adpressed, covering about three-fifths the distance from groin to axilla; snout obtusely pointed; lower eyelid with an undivided, transparent disk; no supranasals; rostral convex, forming an almost straight suture with the frontonasal which is broader than long; nostril large, pierced in the nasal; prefrontals forming a long median suture; frontal very narrow behind, a little

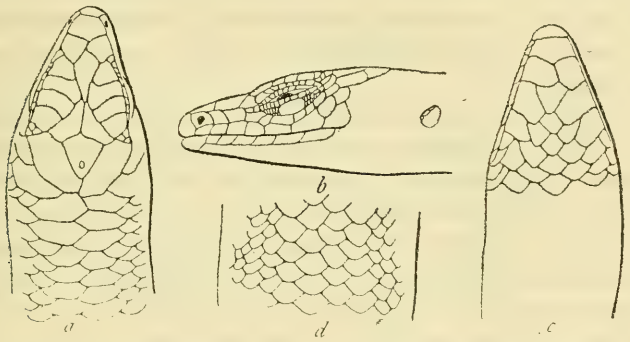


FIGURE 4.—LEIOLOPISMA PRANENSIS. TYPE. U. S. NAT. MUS. NO. 75591. FROM PRAN, PENINSULAR SIAM. *a*, TOP OF HEAD; *b*, PROFILE VIEW; *c*, UNDER SIDE OF HEAD; *d*, DORSAL SCALES AT MID-BODY

shorter than the frontoparietals and interparietals together and in contact with the two anterior supraoculars; a large temporal scale bordering the parietals; four large supraoculars, the first longer than the second; on right side eight superciliaries, on left seven; frontoparietals a little smaller than and distinct from the interparietal, which shows the pineal body very plainly as a round black spot; parietals forming a suture behind the interparietal; two or three pairs of enlarged nuchals, slightly irregular in shape; the suture between fifth and sixth upper labials falling below center of eye; ear opening roundish, less than half the size of the eye opening, with two or three very weakly developed lobules in its anterior margin; about 30 smooth scales around the body, the four median dorsal rows considerably enlarged; the laterals a little smaller than the ventrals and not arranged with perfect regularity; a pair of enlarged preanals; digits compressed, especially towards the tips; all the subdigital

lamellae with a distinct keel, 21 under the fourth toe; tail about one and one-fourth times as long as the head and body.

Dimensions.—Snout to vent, 38 mm.; snout to posterior ear, 9 mm.; snout to shoulder, 14 mm.; snout to center of eye, 4.5 mm.; axilla to groin, 20 mm.; hind leg, 15 mm.; fore leg, 11 mm.; tail, 48 mm.

Coloration (in alcohol).—Upper parts of head and body black, with a pale blue dorsal stripe beginning on the top of the snout and continuing to the end of the tail; a pale lateral stripe beginning on the upper eyelid, passing considerably above ear and shoulder and fading out above insertion of hind limb; below this lateral stripe the black rapidly fades out to an opalescent immaculate cream color which covers the entire under surface; upper surfaces of limbs and tail pale brown, the fingers and toes ringed with brown.

Paratype.—U.S.N.M., No. 76850, collected at Doi Angka, Siam, on December 2, 1928, by Dr. Hugh M. Smith. This specimen is slightly larger than the type. Its dimensions are as follows: Snout to vent, 39 mm.; snout to posterior ear, 11 mm.; snout to shoulder, 16 mm.; axilla to groin, 19 mm.; hind leg, 17 mm.; fore leg, 14 mm.; tail, defective.

The only noticeable difference in the structure of the two is to be found in the ear opening which is elongate in the paratype, while nearly round in the type. The paratype has stronger markings than the type. The lateral stripe from axilla to groin, barely discernible in No. 75591, is quite well defined in No. 76850, as are the black bands encircling the fingers and toes at the joints. Dr. Hugh M. Smith notes that the tail of the Doi Angka lizard was bright orange. The scales on upper surfaces of the limbs are heavily dotted with dark brown at the base; in the type this pigmentation is less pronounced. There are 21 subdigital lamellae under the fourth toe of No. 76850 and 32 scales around the body. There is but one pair of enlarged nuchals; these are much larger, however, than the nuchals on the type specimen.

Relationship.—While the new species is very distinct from any of the described Malayan species of *Leiolopisma*, yet it seems considerably closer to *L. vittigerum* than to any of the others, because both species have conspicuously enlarged dorsal scales. They differ in coloration, in the number of enlarged dorsals, in the keeling and number of the subdigital lamellae and in the number of scale rows around the body.

LEIOLOPISMA KOHTAOENSIS Cochran

Leiolopisma kohtaoensis COCHRAN, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927, p. 188.

U.S.N.M.		
72282–3	Koh Tao, Gulf of Siam	Dec 31, 1926.
72284 type	do	Do.
76146–7	do	Sept. 18, 1928.

In No. 76146, received since the publication of my original description, the prefrontals do not quite meet, allowing a short suture between the frontal and the frontonasal. In the paratype, No.

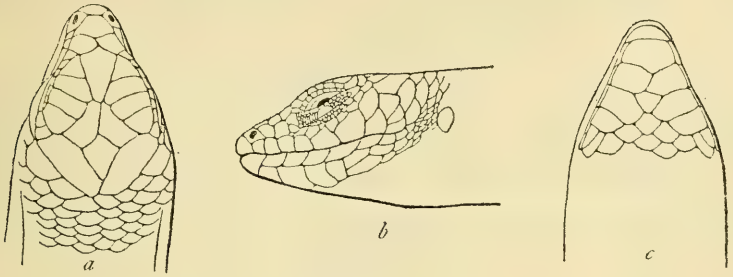


FIGURE 5.—LEIOLOPISMA KOHTAOENSIS. TYPE. U. S. NAT. MUS. NO. 72284. FROM KOH TAO, GULF OF SIAM. *a*, TOP OF HEAD; *b*, PROFILE VIEW; *c*, UNDER SIDE OF HEAD

72283, the contact between the prefrontals is very short indeed, as I have already recorded.

DASIA OLIVACEA Gray

U.S.N.M.			
72234 (S2759)	Bangnara		July 22, 1926.
76061 (S3840)	Ban Kiriwong		July 10, 1928.
76833 (S4055)	Kao Seming		Oct. 10, 1928.

[76061. "Krong kreng." Back rich gray-brown with crossbands of black and white; terminal part of tail uniform brown; belly bright grass-green; edge of eyelids pale yellow.—H. M. S.]

TROPIDOPHORUS BERDMOREI (Blyth)

U.S.N.M.			
76842 (S4106)	Khun Tan Mts		Nov. 22, 1928.

SERPENTES

TYPHLOPS BRAMINUS Daudin

U.S.N.M.			
72319	Bangkok		Jan. 10, 1927.

The Siamese name for this burrowing snake is "ngu din" (= earth snake).

TYPHLOPS FLOWERI Boulenger

U.S.N.M.			
76163	Bangkok		May 30, 1928.

This specimen was taken from *Xenopeltis unicolor*, 75689, and is the first found since Boulenger described the type in 1899 from a Siamese specimen without definite locality sent to him by Flower. The present one has 18 scale rows around the body. The total length is 93 mm., the tail measures 3.5 mm., while the diameter of the body is 1.5 mm.

PYTHON RETICULATUS Schneider

U.S.N.M.		
67491 (S727)	Paknam	Nov. 8, 1923.

This young snake has 13 upper labials, the first four deeply pitted, the seventh entering the eye; 69 scale rows around the body; 302 ventrals; 85 caudals, partly single.

CYLINDROPHIS RUFUS (Laurenti)

U.S.N.M.		
70291–5 (S2040, S2091, S1634, S2075, S2111).	Bangkok	Dec. 16, 1924–Sept. 23, 1925.
72062–5 (S2890, S2345, S2348, S2812).	----do	Dec. 16, 1925–Dec. 1, 1926.
72246, juvenal	Bangsorn	Oct. 1926.
72712 (S3122)	Bangkok	Feb. 1927.
75451 (S3519)	Nong Ri, Nakon Nayok	June 5, 1927.

[This snake is called "ngu kon kob" (=tail-biting snake). The belief is quite general among Siamese that it bites with its tail. One version of the popular belief is that it bites with its head when the moon shines and with its tail on dark nights. One of my assistants assures me a friend was killed by being bitten with the tail of this snake. It is not infrequently seen in the Bangkok roads on rainy nights, coiled tightly with its head concealed in its folds and its tail erect.—H. M. S.]

XENOPELTIS UNICOLOR Reinwardt

U.S.N.M.			
67506 (S595)	Bandon	1922	V 175; C 27.
70296 (S988)	Bangkok	October 1924	V 179; C 26.
72134 (S2540)	Nong Khor	Mar. 21, 1926	V 179; C 30.
72193 (S2886)	Raheng	Oct. 17, 1926	V —; C 28.
75687 (S3744)	Bangkok	May 30, 1928	V 182; C 27.
75688 (S3745)	do	do	V 184; C 28.
75689 (S3746)	do	do	V 181; C 27.
75690 (S3732)	Tonburi	June 30, 1927	V 186; C 26.

[75687–89. Under decaying vegetation near water. Color of back varying with the individual, from dark gray to nearly black, below white or pink; neck ring like belly; 75689 was the darkest on back and had the richest pink on under side. A brown worm was extending from vent when this snake was taken.—H. M. S.] The "worm" is a *Typhlops floweri*, now U. S. N. M. No. 76163.

The specimen from Bandon was collected by Mr. Havmöller. The species is called by the Siamese "ngu seng atit" (=sun-ray snake), and even in perservative shows the beautiful glowing iridescence which suggests the name. Regarding the specimen from Raheng, Dr. Hugh M. Smith notes that it is "reputed to be very poisonous" there.

ACROCHORDUS JAVANICUS Hornstedt

U.S.N.M.			
67569	Bangkok	November 1923	(head).
65693 (S3779)	do	Apr. 28, 1928.	

["Ngu nuang chang" (=elephant trunk snake).—H. M. S.]

CHERSYDRUS GRANULATUS (Schneider)

U.S.N.M.		
67526–7 (S279–80)	Chao Phya River, off Paknam	Aug. 12, 1923.
67567 (S240)	do	Aug. 9, 1923.
67568 (S1048)	Bangpakong River	Feb. 13, 1924.
76161 (S3993), juvenal	Koh Tao, Gulf of Siam	Sept. 24, 1928.

The Koh Tao snake was collected by Dr. A. Kerr on a sand beach. Its Siamese name is "ngu pa ki liew."

NATRIX PISCATOR (Schneider)

U.S.N.M.			Ventrals	Caudals
67509 (S309)	Nontaburi	Aug. 7, 1923	135	76
70320 (S2088)	Bangkok	Aug. 24, 1925	139	74
70321 (S2109)	do	Sept. 22, 1925	143	--
70322 (S2165)	do	Oct. 13, 1925	141	84
70323 (S2241)	do	Nov. 7, 1925	137	78
72073 (S2863)	do	Nov. 2, 1926	133	81
72074 (S2877)	do	Nov. 15, 1926	134	--
72710 (S3106)	do	November 1926	133	66
75691 (S3734)	Tonburi	May 15, 1928	135	--

This water snake is very common in Bangkok according to Dr. M. A. Smith's account of The Snakes of Bangkok. In Dr. Hugh M. Smith's collection, all but one of the specimens were caught at that city. It is called "ngu pla," meaning "fish snake."

In all cases the scales around the body are in 19 rows, the two outer being smooth. The only noteworthy feature of the head scalation is that No. 70320 has but one anterior temporal; this is rarely the case, two being the rule.

NATRIX SUBMINIATA (Schlegel)

U.S.N.M.			Ventrals	Caudals
67502 (S716)	Nontaburi	Sept. 2, 1923	146	83
68503 (S308)	do	Aug. 18, 1923	140	71
67504 (S923)	Bangkok	Dec. 6, 1923	148	82
70318 (S1974)	do	May 30, 1925	149	--
70319 (S2067)	do	Aug. 8, 1925	146	79
70337 (S2156)	Nong Khor	Sept. 27, 1925	144	68
70343 (S2097)	Nong Mong	Aug. 24, 1925	153	81
70344 (S2101)	do	Aug. 29, 1925	148	90
70349, juvenal	Pak Jong	May 18, 1925	154	91
70358 (S2006)	Lam Tong Lang	July 7, 1925	152	82
72071 (S2873)	Bangkok	Nov. 5, 1926	144	--
72072 (S2765)	do	Aug. 5, 1926	147	75
72135 (S2539)	do	Mar. 21, 1926	149	83
75635 (S3624)	Kanburi	Apr. 9, 1928	---	85
76029 (S3880)	Ban Tadi	July 14, 1928	138	74
76083 (S3894)	Ban Prakien	July 15, 1928	140	66

The head scalation is normal in all, excepting No. 70319, where four postoculars appear on one side of the head, and No. 72072, which has three posterior temporals. The stomach of No. 72072 contained a frog, *Oxydozyga martensi*, No. 72115.

[76029. Back of neck red, side of neck bright yellow.—H. M. S.]

[75635. "Ngu kapa chinchuk." General color of back finely mixed light and dark green, with white edges and scales; head above greenish blue; nape black; eye in a black spot, a yellow area below eye; a yellow spot behind and below eye; a postnape line yellow, as is under side of head. Said to be poisonous.—H. M. S.]

According to a recent study by Doctor Mell [6] the Siamese race of *subminiata* appeared to merit subspecific distinction, since his series of 12 specimens showed a uniformly low scale count, ranging between 143 and 157. In the 15 snakes in my series on which ventral plates could be counted the range was even a little lower, being between 138 and 154 with an average of 146.5, thus corroborating Doctor Mell's observations so far. Eleven snakes from Peninsular Siam collected by Dr. W. L. Abbott range from 137 to 148, averaging 140.1. But a series of 28 specimens from Java, the type locality of the typical *subminiata*, shows a variation of 137 to 149, the average being 141.4, and this seems insufficient to warrant subspecific distinction between Siamese and Javanese snakes which are otherwise similar.

NATRIX CHRYSARGA (Schlegel)

U.S.N.M.			Ventrals	Caudals
70332 (S2151)	Nong Khor	Sept. 22, 1925	157	86
70333 (S2152)	do	Sept. 23, 1925	159	80
70334 (S2154)	do	Sept. 24, 1925	158	80
72135 (S2539)	do	Mar. 21, 1926	149	83
72136 (S2537)	do	Mar. 20, 1926	154	82
72147 (S2393)	Koh Chang	Jan. 4, 1926	159	--

NATRIX STOLATA (Linnaeus)

U.S.N.M.		
70345 (S2103)	Nong Mong	Sept. 1, 1925.
75452 (S3520)	Nong Ri, Nakon Nayok	June 5, 1927.

The scale formula for No. 70345 is as follows: 19 scale rows; 145 ventrals; divided anal; caudals —; 8 upper labials; oculars 1+3; temporals 1+3. For No. 75452, the formula is: 19 scale rows; 147 ventrals; divided anal; 78 caudals; 8 upper labials; oculars 1+¾; temporals 1+2.

LYCODON AULICUS (Linnaeus)

U.S.N.M.			Ventrals	Caudals
72051 (S2786)	Tonburi, Bangkok	Aug. 26, 1926	200	63
72308 (S2923)	Koh Tao, Gulf of Siam	Jan. 2, 1927	191	74
75686 (S3569)	Bangkok	Apr. 12, 1928	197	65
76160 (S3982)	Koh Tao, Gulf of Siam	Sept. 18, 1928	184	72

[6] Congr. Internat. Zool., Budapest, vol. 10, 1929, p. 1472.

The Bangkok specimen, No. 72051, is an adult measuring 531 mm. in length, the tail measuring 88 mm. In coloration it agrees well with Dr. Malcolm Smith's description of typical Siamese specimens.[7]

The snake from Koh Tao, No. 72308, is a young one, agreeing in every respect with the above, excepting that the light blotch on either side of the occiput is less invaded by the dark brown of the body color. Regarding this individual the collector has noted: "Black and light green; labials white, with black spots in definite series; top of head black."

[75686. Markings on nape side of head and along jaws pale yellow; a bright yellow line along upper jaw from eye to end of snout; back dull blackish brown with whitish markings, top of head reddish brown, belly white.—H. M. S.]

LYCODON LAOENSIS Günther

U.S.N.M.			
72317	(S2930)	Bandon	Jan. 7, 1927.

This individual has 17 scale rows, 167 ventrals, a divided anal, 64 caudals, 9 upper labials, oculars 1+2 and temporals 2+3. It is to be noted that the lowest number of ventrals hitherto recorded for this species is 175. The coloration of my specimen corresponds to the figure (Cat. Snakes Brit. Mus., vol. 1, 1893, pl. 24, fig. 3), except that the white bands are very much more distinct and less invaded with dark pigment.

DRYOCALAMUS DAVIDSONII (Blanford)

U.S.N.M.			
67512	(S312)	Bangkok	1919.
76858	(S4144)	do	Dec. 22, 1928.

This snake is apparently quite rare, as Dr. Malcolm Smith lists only two specimens of it taken in Bangkok. The earlier specimen collected by Dr. H. M. Smith is larger than those previously recorded. It measures 825 mm., of which the tail comprises 178 mm. The scale formula is given: 13 rows around the body; 254 ventrals; an undivided anal; 95 caudals; 7 labials; 1 loreal; no preocular; 2 postoculars; on one side of the head a single anterior temporal, and two anterior temporals on the other side; two posterior temporals on both sides. The coloration is exactly as given by Boulenger, except that there are brown spots behind the eyes extending over the anterior temporals. The latter specimen, a very young one, has 13 scale rows; 253 ventrals; 1 anal; 102 subcaudals; 1 loreal; no preocular; 2 postoculars; temporals 1+2.

[7] The Snakes of Bangkok, Journ. Nat. Hist. Soc. Siam, vol. 1, 1914, p. 17.

PTYAS MUCOSUS (Linnaeus)

U.S.N.M.			Ventrals	Caudals
67515 (S755), juvenal	Sikuk	Nov. 15, 1923	197	11
70316 (S981)	Bangkok	July 12, 1924	195	11
70317 (S2089)	do	Aug. 26, 1925	197	10
72723 (S2590)	do	Apr. 18, 1926	201	11
72724 (S2253)	do	Nov. 28, 1925	200	11
75692 (S3795)	do	June 22, 1928	204	--

[A rat snake about 2 meters long once ascended a clump of bamboo in my yard and caught an owl, which it brought to the ground and began to devour. It has been met with a number of times on the golf course of the Royal Bangkok Sports Club.—H. M. S.]

PTYAS KORROS (Schlegel)

U.S.N.M.			Ventrals	Caudals
67514 (S726)	Nontaburi	Oct. 23, 1923	168	133
70330 (S2219)	Bangkok	Oct. 17, 1925	173	131
72070 (S2637)	do	May 31, 1926	167	---
72148 (S2395)	Koh Chang	Jan. 16, 1926	165	145
76001 (S3897)	Nakon Sritamarat	July 17, 1928	168	134
76080 (S3891)	Ban Lem Ngao	July 15, 1928	172	---

[76001. Back olive green, with whitish vertical lines on anterior fifth of body; under side of body and head yellowish green to greenish white; a pale yellow ring around eye, incomplete above.—H. M. S.]

[76080. "Ngu sing." Back uniform brown, anterior third of belly beautiful yellow green, posterior two-thirds whitish green.—H. M. S.]

COELOGNATHUS RADIATUS (Schlegel)

U.S.N.M.			Ventrals	Caudals
67513 (S717)	Nontaburi	Sept. 2, 1923	244	92
72318 (S2928)	Bandon	Jan. 4, 1927	238	95
76038 (S3878)	Ban Kiriwong	July 13, 1928	228	91

The Nontaburi specimen has 10–9 upper labials; the Bandon snake has 8–9 upper labials. The Bandon specimen had the "back light green, with black markings; lines on head black; belly pale creamy, with under side of tail pale salmon."

AHAETULLA BOIGA (Lacépède)

U.S.N.M.		
67507 (S307)	Nontaburi	Aug. 20, 1923.
70327–9 (S1872, S2043, S2231).	Bangkok	Mar. 31–Oct. 23, 1925.
72060 (S2596)	do	Apr. 21, 1926.
72139 (S2538)	Nong Khor	Mar. 21, 1926.
72230 (S2761)	Bangkok	July 22, 1926.
75453 (S3521)	Nong Ri, Nakon Nayok	June 5, 1927.
75680 (S3789)	Bangkok	June 16, 1928.
76017 (S3820)	Upper Tadi Stream, Nakon Sritamarat.	July 7, 1928.
76028 (S3830)	Ban Tadi	July 9, 1928.

[75680. "Ngu saiman pra-indra"—Brahmin curtain-cord snake. Back bronze green with inferior margin black; top of head brown;

lateral stripe black, separated from back by a pale golden yellow stripe; belly pale yellow; scales of anterior third of back showing light blue background when pulled apart. A very active little snake, not uncommon in Bangkok. This one contains a small animal (lizard?).—H. M. S.] The lizard is a young *Calotes*.

[76017. "Ngu saipan." Looks somewhat different from same kind of snake at Bangkok. Top of head and back burnished bronze; blue area under scales appearing as rhomboidal spots when scales are pulled aside.—H. M. S.]

[76028. Bright greenish-yellow on side of neck.—H. M. S.]

[This is a common snake in Bangkok and in many districts of Siam. Its reputed habit of leaping from tree to tree has not been observed by me, but on one occasion, in 1926, an example of its leaping ability was given in my house in Bangkok. One morning as I got out of bed a full-sized snake of this species was found sunning itself stretched on the sill of a double door opening on a veranda. As I approached it ran behind a door and climbed to the top of the door whence it sprang to the rail of the veranda and thence under the eaves. Some time afterwards I found that the shortest distance from the door to the rail was 104 cm., but as the snake leaped the distance was over 145 cm.—H. M. S.]

HOLARCHUS PURPURASCENS (Schlegel)

U.S.N.M.			Ventrals	Caudals
70324 (S1913)	Bangkok	Apr. 21, 1927	175	38
70325 (S1925)	do	May 18, 1925	165	46+
70326 (S2169)	do	Oct. 13, 1925	173	38
70355 (S2007)	Lam Tong Lang	July 7, 1925	171	52
72066 (S2874)	Bangkok (H. M. Smith's yard)	Nov. 5, 1926	177	37
72067 (S2876)	Bangkok	Nov. 11, 1926	167	43
72068 (S2880)	Bangkok (H. M. Smith's yard)	Nov. 17, 1926	174	37
72069 (S2902)	Bangkok	Dec. 15, 1926	172	35
75683 (S3490)	do	Aug. 4, 1927	176	39
75684 (S3493)	do	do	174	38
76090 (S3913)	Pichit	Aug. 8, 1928	160	42
76122 (S3943)	Bangkok	Aug. 24, 1928	167	45

[Called "ngu hao (=hiss) pi (=flute) keo (=glass)" by the Siamese, who are very familiar with it; it is said to make a noise like a cricket.—H. M. S.]

The young specimen from Lam Tong Lang agrees perfectly with young Bangkok snakes in coloration. In two adult Bangkok snakes, 70324 and 70325, the color markings are not distinct, while in 72068, also fully adult, the markings are as bright as in the young. All have the same pattern which Dr. Malcolm Smith describes as characteristic of the Bangkok snakes.[8] In all cases the scale-rows around the body are 21 in number; there is a single preocular and 1 subocular. The

[8] Journ. Nat. Hist. Soc. Siam, vol. 1, No. 2, 1914, p. 98.

stomach of 72067 contained two young toads (*Bufo melanostictus*, 72116 and 72117).

HOLARCHUS TAENIATUS TAENIATUS (Günther)

U.S.N.M.			Ventrals	Caudals	Temporals
67505 (S720), male	Nontaburi	Sept. 2, 1923	154	44	1+1+2
67319, female	Bangkok	Apr. 13, 1924	162	35	1+1+2
70289 (S1989), female	do	July 2, 1925	169	33	1+1+2
70290 (S2168), male	do	Oct. 13, 1925	157	45	1+2
70340 (S2096), male	Nong Mong	Aug. 24, 1925	153	42	1+1+2
70341 (S2099), male	do	Aug. 27, 1925	153	42	1+1+2
70346 (S1960), male	Pak Jong	May 18, 1925	155	41	1+1+2
72053, male	Bangkok	Dec. 26, 1925	154	41	1+1+2
72054 (S2736), male	Bangkok (H. M. Smith's yard).	July 8, 1926	150	43	1+1+2
72055 (S2872), male	do	October, 1926	156	41	1+1+2
72056 (S2892), male	do	November, 1926	157	43	1+1+2
72057 (S2497), female	Bangkok	Mar. 2, 1926	163	33	♀+1+2
72713 (S3022), male	Korat	Jan. 19, 1927	151	44	♀+1+2
72714 (S2023), juvenal	do	do			1+1+2
75685 (S3525), male	Bangkok	Apr. 17, 1927	157	42	1+1+2

[72713. "Ngu nok yung"=peacock snake. Back light brown, with 2 median and 1 lateral dark brown stripes, the median stripes cross-hatched with fine lines of golden-yellow; belly with black spots, the ground color pink anteriorly, becoming bright red posteriorly, especially intense on tail. Said to be a common snake in the Korat region.—H. M. S.]

[72714. Light brown with dark brown markings on back and head; belly light red, with black spots.

These two snakes collected for me by Phra Anuwati, chief forest officer at Korat.—H. M. S.]

In the 15 Siamese snakes which I have called by this name there is considerable variation from the distinctive characters given by Boulenger and Smith [9] in their notes on this species compared with *S. mouhoti*. There are constantly 19 scale rows around the body in our specimens of *taeniatus*, and in this point our series agrees with Doctor Smith's counts. But the tip of the tongue is black and the remainder grayish instead of the whole organ being red (or bleached white in alcohol) as Doctor Smith had observed. The headmark is approximately arrow shaped, and there are no tail bars, but in every case there is an incomplete collar reaching to well below the corner of the mouth. A subocular is present on both sides of the head in No. 70340 from Nong Mong, and on one side of the head in the other Nong Mong specimen, No. 70341. In all my specimens with two exceptions there is one very small anterior temporal followed by one

[9] Journ. Nat. Hist. Soc. Siam, vol. 1, No. 2, 1914, p. 70.

very long one, which in turn is bordered by two, so that the formula reads 1+1+2. In No. 70290, in No. 72057 on one side of the head, and in No. 72713, there is a long anterior temporal followed by two posterior ones. In none of my specimens are there two anterior temporals which Doctor Smith gives as the normal occurrence in his series of 15.

Nos. 67319, 70289, and 72057 are females, as shown by the higher ventral count and lower number of subcaudals. Three eggs, preserved with No. 67319, collected in the yard of Dr. Hugh Smith's residence in Bangkok, measure between 13.5 and 14 mm. in length and 8 to 8.5 in width.

HOLARCHUS TAENIATUS MOUHOTI (Boulenger)

U.S.N.M.		
67247	Rajaburi	July 30, 1923.

One specimen from Rajaburi seems referable to this variety on color pattern, for it has the two tail bars and the heart-shaped headmark mentioned by Dr. Malcolm Smith. The tongue is conspicuously tipped with black and the base is likewise black; the intervening space now bleached to white may once have been red. The collar, however, is not more complete than in the specimens of *taeniatus* just listed. There is a subocular on both sides of the head. The single small anterior temporal is followed by a long, large one; this in turn is followed by two scales on one side of the head and by one scale on the other, so that the temporal scale formula reads 1+1+½. There are 17 scale rows around the body, 151 ventrals, and at least 37 subcaudals, although the end of the tail is missing.

HOLARCHUS VIOLACEUS (Cantor)

U.S.N.M.		
72161 (S2910)	Pak Jong	Dec. 22, 1926.
72309 (S2939)	Koh Tao, Gulf of Siam	Jan. 1, 1927.
75585 (S3763)	Pran	May 25, 1928.

The headplates of the Koh Tao specimen resemble very closely the drawing of *Simotes multifasciatus* in Jan's Iconographie des Ophidiens.[10] A marked difference in scutellation is found in the seventh supralabial, which in the Koh Tao specimen is very high and permits of only one posterior temporal, while this labial is lower in the figure of *multifasciatus* and there are two posterior temporals. The frontal plate is about equal in length to the parietals in *multifasciatus*, while in my specimen the parietals are longer than the frontal.

The ventral coloration is much the same, there being the quadrangular dark spots in two rows, with a lightened area in the middle of the belly between them. The Koh Tao specimen, however, is unspotted above, the scales appearing a dark purplish gray with the

[10] Livr. 12, pl. 4, fig. 2.

borders of the scale edged darker and lighter to form a variation, but without any bars across the body. There are traces of markings on the head which resemble the figure also. The formula is: 17 scale rows; 176 ventrals; undivided anal; 42 caudals; 7–8 upper labials; oculars 1+2; temporals 1+1; a subocular is present.

The Pak Jong specimen is dull colored and seems to fit the color variety A, as defined by Boulenger.[11] This snake has 7 upper labials and no subocular, while typical examples of *violaceus* possess 8 upper labials and usually a subocular. The scale formula is as follows: 17 scale rows; 175 ventrals; an undivided anal; 40 caudals; 7 upper labials, the third and fourth entering the eye; oculars 1+2; temporals 1+2.

Dr. Malcolm Smith has examined these specimens also. He writes me that "the number of labials may be 7 or 8, but except for that, the species is fairly constant as regards scalation."

The Pran specimen is very much like the Pak Jong snake in color, except that its dark nuchal mark is more distinct. The formula is: 17 scale rows, 174 ventrals; undivided anal; 38 caudals; 8 upper labials; oculars 1+2; temporals 1+2. A subocular is present below the preocular.

GONGYLOSOMA SCRIPTUM (Theobald)

U.S.N.M.		
76103 (S3932)	Kao Luang, Nakon Sritamarat	July 20, 1928.

This very rare snake has the following scale formula: 13 scale rows; 133 ventrals; a divided anal; 98 caudals; oculars 2+2; temporals 1 (very long)+2; supralabials 8. The head and body measure 240 mm. and the tail 160 mm. The coloration is that given by Boulenger, except that there is no white collar on the nape. A white bar edged with black arises from commisure of the mouth and ends bluntly just outside the lower border of the parietal shields, and this may be a trace of the collar.

ENHYDRIS ENHYDRIS (Schneider)

U.S.N.M.			Ventrals	Caudals
70309 (S1985)	Bangkok	June 29, 1925	168	68
70310 (S1992)	do	July 14, 1925	163	63
70311 (S2083)	do	Aug. 18, 1925	170	75
70312 (S2087)	do	Aug. 23, 1925	167	75
70313 (S2150)	do	Oct. 10, 1925	172	64+
70314 (S2237)	do	Oct. 30, 1925	161	64
70315	do	Aug. 8, 1925	---	--

This fresh-water snake, common in Bangkok, is represented in this collection by seven specimens. The largest one, an adult female, No. 70314, contains a number of embryos nearly developed.

In all cases the head scalation is absolutely normal, and there are 21 scale rows around the body.

[11] Cat. Snakes Brit. Mus., vol. 2, 1894, p. 223.

ENHYDRIS JAGORII (Peters)

U.S.N.M.			
67516 (S903)	Sikuk River at Ban Pan	Nov. 25, 1923.

Our only specimen of this species has 21 scale rows around the body, 123 ventrals, and more than 23 caudals, the tail being incomplete. The head scales are quite normal.

ENHYDRIS PLUMBEA (Boie)

U.S.N.M.			
67508 (S477)	Bandon Bight, Gulf of Siam	Sept. 27, 1923.

The scalation of this specimen is normal in every way; there are 123 ventrals and 36 caudals.

HOMALOPSIS BUCCATA (Linnaeus)

U.S.N.M.			
67510 (S719)	Nontaburi	Sept. 2, 1923.
70302 (S1991), adult female.	Bangkok	July 13, 1925.
70303 (S1991), 16 embryos from 70302.	do	Do.
70304–8 (S2039, S2084, S2112, S2115, S2233).	do	July 30–Oct. 25, 1925.
70362 (S1945)	Bangkok (yard of H. M. Smith's residence).	May 30, 1925.
72711 (S2339)	Bangkok	Dec. 12, 1925.

This very common fresh-water snake is well represented in the collection. The adult female from Bangkok, No. 70302, measures 1,375 mm. in total length, the tail being 275 mm. long. This snake exceeds by 65 mm. the largest one reported by Dr. Malcolm Smith.

Dr. Hugh M. Smith has been kind enough to furnish me with the following note on this species: "The local name is 'ngu pla' or 'fish snake,' a name borne by several species of similar habits. It (No. 70302) was caught on a line baited with a small whole fish. This species has been frequently taken in my yard here. It is said by one of my Siamese assistants to be poisonous when about to have young, but I do not put much credence in the statements of Siamese regarding the poisonous properties of snakes."

HURRIA RHYNCHOPS (Schneider)

U.S.N.M.			
67561 (S989)	Near Singora	Nov., 1923.
72717–8 (S2659, S2677)	Lem Sing	June 9–11, 1926.

This aquatic serpent has been reported before from Singora, where No. 67561, quite a young one, was collected by Mr. R. Havmöller.

ERPETON TENTACULATUS Lacépède

U.S.N.M.			
67500 (S290)	Bangkok	Aug. 15, 1923, pond.
67501 (S884)	Chao Phya River, near Paknampo.	Nov. 21, 1923, from a fish chute.

The head and anterior portion of the body is all that was preserved of the adult from Bangkok, No. 67500. The young one, 67501, has 13 upper labials; the adult has 13 and 14; both specimens have 37 scale rows around the body. Doctor Smith says that its local name

at Paknampo is "ngu kadang." He adds that it is not rare in Bangkok and other parts of Siam.

BOIGA MULTOMACULATA (Boie)

U.S.N.M.		
75450 (S3518)	Nong Ri, Nakon Nayok	Jan. 10, 1927.

BOIGA DENDROPHILA (Boie)

U.S.N.M.			Ventrals	Caudals
72725 (S2871)	Tung Song	October, 1926	217	95

PSAMMODYNASTES PULVERULENTUS (Boie)

U.S.N.M.		
70335–6 (S2155)	Nong Khor, near Sriracha	Sept. 25–Oct. 1, 1925.
70348	Pak Jong	May 18, 1925.
70356	Lam Tong Lang, near Pak Jong.	July, 1925.
72140 (S2882)	Nong Khor	Nov. 11, 1926.
72187 (S2881)	Sriracha	Nov. 10, 1926.
72715	Nong Nam Kiew	Feb. 15, 1927.
75592	Pran	May 25, 1928.
76835 (S4049)	Kao Seming	Oct. 13, 1928.
76843 (S4107)	Khun Tan Mts	Nov. 22, 1928.

PASSERITA PRASINA (Boie)

U.S.N.M.		
70359 (S2009)	Lam Tong Lang	July 19, 1925.
72137–8 (S2543, S2883)	Nong Khor	March 25–Nov. 11, 1926
72176 (S2817)	Bang Suk	Aug. 20, 1926.
76068 (S3869)	Ban Hui Ta	July 12, 1928.
76091 (S3914)	Pichit	Aug. 8, 1928.
76102 (S3915)	Kao Luang, Nakon Srita-marat.	July 13, 1928.

[76068. Exceedingly bright grass green on back, bright yellow green on belly. Elevation about 700 feet—H. M. S.]

[76091. "Ngu khao (=white), pak (=mouth), chinchuk (=house-lizard)." Found by me alive in a country road. A very striking object—pure white with black markings. Known to local people who told me it was *mi phit* (poisonous). I made them laugh when I told them I kept one of these in my bed to catch mosquitoes. I do not know whether it is only an albino of the common form.—H. M. S.]

PASSERITA NASUTA (Lacépède)

U.S.N.M.			Ventrals	Caudals
70275 (S1637)	Bangkok	Dec. 24, 1924	194	153
70276 (S1983)	do	June 23, 1925	201	----
70277 (S2042)	do	Aug. 4 1925	200	153
70278 (S2061)	do	Aug. 6, 1925	191	157
70279 (S2070)	do	Aug. 11, 1925	190	----
70280 (S2073)	do	Aug. 13, 1925	203	143
70281 (S2074)	do	do	195	146
70282 (S2118)	do	Sept. 27, 1925	194	149
70283 (S2203)	do	Oct. 16, 1925	202	146
70284	do	Aug. 7, 1925	----	----
72052 (S2741)	Bangkok (H. M. Smith's yard).	July 8, 1926	195	----

This beautiful species is subject to some variability in the region of the upper lip just behind the rostral appendage. Although the number of labials is constantly eight in all my specimens excepting one, which has but seven on one side of the head, there is frequently a horizontal division of one of the labials, which makes an additional scale just below the loreal region. In three cases the third labial is thus divided on one side of the head, and once the second labial is so divided. In one case the third labial is wedged in between the second and fourth, so that it fails to reach the lip border. There are three scales bordering the anterior portion of the eye in the majority of cases, the additional "suboculars" resulting from the horizontal separation of the top portion of the fourth labial. Two postoculars are constantly present. One anterior temporal is more commonly encountered than two; there are constantly two posterior temporals in this collection.

CHRYSOPELEA ORNATA (Shaw)

U.S.N.M.			Ventrals	Caudals
67304	Sikut River	Nov. 15, 1923	220	120
67492 (S718)	Nontaburi	Sept. 2, 1923	237	----
67493 (S721)	do	do	228	120
67494 (S725)	do	Oct. 23, 1923	232	126
67495 (S594)	Bandon	1922	231	----
67496 (S596)	do	1922	221	120
67497 (S597)	do	1922	228	140
67498 (S723)	Bangkok	September, 1924	231	132
67499 (S724)	do	Oct. 26, 1923	228	----
70297 (S2031)	do	July 27, 1924	230	119
70298 (S1809)	do	Mar. 6, 1925	229	140
70299 (S2060)	do	Aug. 6, 1925	236	----
70300 (S2085)	do	Aug. 21, 1925	235	141
70301 (S2232)	do	Oct. 23, 1925	227	119
72058 (S2390)	Bangkok (H. M. Smith's yard).	Jan. 25, 1926	227	135
72059 (S2391)	Bangkok	do	223	135
72149 (S2392)	Koh Chang	Jan. 4, 1926	236	135
72150 (S2394)	do	Jan. 5, 1926	227	139
72162 (S2326)	Pak Jong	Nov. 15, 1925	223	----
72177 (S2818)	Bang Suk	Aug. 24, 1926	226	117
72716 (S2924)	Koh Tao	Jan. 2, 1927	234	132
75681 (S3791)	Bangkok	June 16, 1928	232	122

Our specimens of the beautiful green and black tree snake from the mainland of Siam conform with variety D in Boulenger's Catalogue of Snakes,[12] as Dr. Malcolm Smith has likewise found. We have two snakes from Koh Chang (72149 and 72150) and one from Koh Tao (72716) which show the melanism which is often found in island forms. In these specimens the mesial black line on each scale has become greatly widened, so that the entire upper part of the body seems to

[12] Vol. 3, 1896, p. 197.

be black with very inconspicuous lighter spots on the lateral portions of each scale. One of the two Koh Chang specimens (72149) is unlike all the others in having black spots in the centers of the labial scales. This snake likewise is without loreal plates.

In all specimens the scale preceding the anal plate was divided like it. The maximum number of subcaudals listed by Boulenger is 138; my series raises the number slightly, as two of the snakes have 140 each and one specimen has 141. The specimens from Bandon (67495–7) were collected by Mr. R. Havmöller. The young specimen, 70301, was captured in the Hotel Royal at Bangkok.

DISTEIRA CYANOCINCTA (Daudin)

U.S.N.M.		
67519 (S256)	Chao Phya River, off Paknam.	Aug. 10, 1923.
67522 (S265)	do	Aug. 11, 1923.
67529 (S236)	Gulf of Siam	Aug. 8, 1923.

As the sea snakes have just been monographed by Dr. Malcolm Smith, I make no further notes on the species included in Dr. Hugh M. Smith's collection other than to list them with data. Many of the identifications were made by Dr. Malcolm Smith at the United States National Museum.

DISTEIRA CAERULESCENS (Shaw)

U.S.N.M.		
67565 (S1067)	Bangpakong River	Feb. 14, 1924.
72227–8(S2801, S2804)	Gulf of Siam, off Chao Phya River.	Aug. 20, 1926.
75449 (S3404)	Chantabun River	Aug. 5, 1927.

DISTEIRA VIPERINA (Schmidt)

U.S.N.M.		
67549 (S977)	Near Singora, Siam	November, 1923.

Collected by Mr. R. Havmöller.

DISTEIRA KLOSSI (Boulenger)

U.S.N.M.		
72229 (S2805)	Gulf of Siam, off Chao Phya River.	Aug. 20, 1926.

DISTEIRA TORQUATA DIADEMA (Günther)

U.S.N.M.		
67520 (S252)	Chao Phya River, off Paknam.	Aug. 9, 1923.
67523 (S276)	do	Aug. 12, 1923.
67528 (S235)	Gulf of Siam	Aug. 8, 1923.
67530 (S237)	do	Do.
67533–4 (S268–9)	Gulf of Siam off Chao Phya River.	Aug. 11, 1923.
67536–7 (S282–3)	do	Aug. 12, 1923.
67564 (S1066)	Bangpakong River	Feb. 14, 1923.
67566 (S1068)	do	Do.

DISTEIRA FASCIATA ATRICEPS (Günther)

U.S.N.M.		
70360 (S2090)	Gulf of Siam, Hua Hin	Aug. 31, 1925.

A single sea-snake which I have referred to this species has 88 ventral plates, 29 scales around the neck and 40 around the body.

LAPEMIS HARDWICKII Gray

U.S.N.M.		
67524–5 (S277–8)	Chao Phya River, off Paknam.	Aug. 12, 1923.
67535 (S270)	Gulf of Siam off Chao Phya River.	Aug. 11, 1923.
67538–41 (S329–32)	do	Sept. 9, 1923.
67542 (S144)	Gulf of Siam off Tachalom	July 20, 1923.
67543 (S41)	Gulf of Siam off Banghia River.	July 3, 1923.
67545 (S43)	do	Do.
67546–7 (S548–9)	Gulf of Siam near Singora	Oct. 5, 1923.
67548 (S976)	do	November, 1923 (R. Havmöller).
67550–4 (S978–82)	do	Do.
67556–60 (S984–988)	do	Do.
72220–1 (S2696–7)	Gulf of Siam off Chao Phya River.	Aug. 20, 1926.
72719–22 (S2284–7)	Mouth of Meklong River	Dec. 7, 1925.

ENHYDRINA SCHISTOSA (Daudin)

U.S.N.M.		
67521 (S264)	Chao Phya River off Paknam.	Aug. 11, 1923.
67531–2 (S238, S257)	Gulf of Siam off Paknam	Aug. 8–10, 1923.
67544 (S42)	do	July 3, 1923.
67555 (S983)	Gulf of Siam near Singora	November, 1923.
67562–3 (1064–5)	Bangpakong River	Feb. 14, 1924 (R. Havmöller).
72222–6 (S2798–800, S2802–3).	Gulf of Siam off Menam Chao Phya.	Aug. 20, 1926.

Dr. Hugh M. Smith notes that "A local name for this snake at the head of the Gulf of Siam is 'kawon' (=soft neck)."

BUNGARUS FASCIATUS (Schneider)

U.S.N.M.		
67511 (S311)	Chiengmai	1915.
72061 (S2733)	Bangkok	June 25, 1926.

The Chiengmai specimen is so badly mutilated that a count of the ventrals is impossible. There are 15 scale rows around the body, and there are 37 subcaudals, single excepting for the last half dozen, which show a distinct tendency to divide. In coloration this specimen agrees fairly well with Dr. Malcolm Smith's description in the Snakes of Bangkok. There are 25 yellow bands on the body, a few of those toward the middle being marked with small black patches. The Bangkok specimen has 15 scale rows, 215 ventrals, 35 subcaudals,

the last three of which are divided, and 22 yellow bands on the body. There are no black patches within the yellow bands ventrally, however. As these are young snakes, the enlarged tip at the end of the tail is not yet in evidence.

[During my five years' residence in Siam I have rarely seen this species. I have on two or three occasions seen the snake crossing city roads, and in 1928 I noticed two that had been killed by automobiles on roads near my house.—H. M. S.]

BUNGARUS FLAVICEPS Reinhardt

U.S.N.M.		
70361 (S2145)	Bang Yai Jang, southwest of Rajaburi.	Aug. 15, 1925.

This snake, the second one of its kind to be taken in Siam, is a large one, and in its stomach there are the remains of an exceedingly large bamboo snake, *Trimeresurus gramineus*. This species of krait has been reported once from Nakon Sritamarat by Dr. Malcolm Smith in The Poisonous Land Snakes of Siam.[13] In this specimen there are 13 scale rows around the body, 222 ventrals, and 52 subcaudals, the first 18 of which are single, the remainder double. The head and tail are orange red, the body scales above are black, the interstitial skin showing pale pink between them in this distended specimen. The black color clouds the extreme ends of the ventral plates, which are otherwise a deep buff color (faded by alcohol). There is no lateral light streak on the outer rows of scales, nor is there any vertebral light stripe.

NAJA HANNAH (Cantor)

U.S.N.M.			Ventrals	Caudals
72726 (S2909)	Pak Jong	Dec. 19, 1926	239	90 (20 single+70 double).

NAJA NAJA (Linnaeus)

[I have sent to the museum no specimens of cobra, as I have very rarely come across the species. It occurs within the city limits of Bangkok, and occasionally I hear of cobras being killed about or in the houses of my friends.—H. M. S.]

CALLIOPHIS MACULICEPS (Günther)

U.S.N.M.		
70331 (S2153)	Nong Kohr	Sept. 24, 1925.

A single specimen of this small snake shows an unusually low ventral count of 193; the lowest count by Boulenger is 205 and the lowest given by Glydenstolpe is 198. The subcaudals number 21; there are 7 labials, one prae- and two postoculars and a single large temporal scale. The coloration agrees with Boulenger's description, excepting that the tail beneath has a few irregular black patches, in addition to the two black rings characteristic of the species.

[13] Journ. Nat. Hist. Soc. Siam, vol. 6, no. 1, 1923, p. 61.

CALLIOPHIS HUGHI Cochran

Callophis hughi COCHRAN, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927, p. 190.

U.S.N.M.			
72307 (S2940) type	Koh Tao, Gulf of Siam	Jan. 1, 1927.

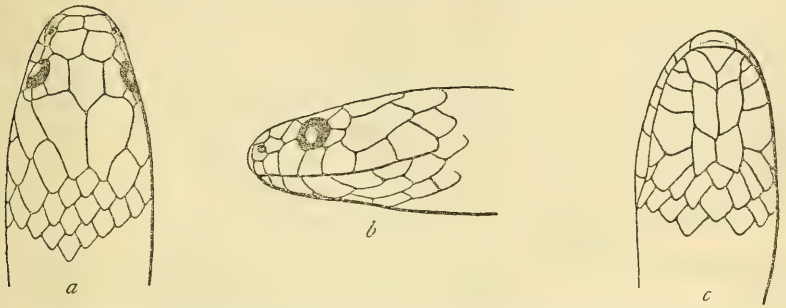


FIGURE 6.—CALLIOPHIS HUGHI. TYPE. U. S. NAT. MUS. NO. 72307. FROM KOH TAO, GULF OF SIAM. *a*, TOP OF HEAD; *b*, PROFILE VIEW; *c*, UNDER SIDE OF HEAD

PAREAS CARINATUS (Boie)

U.S.N.M.		
72175 (S2813)	Bang Suk, near Pak Jong	Aug. 16, 1926.

This is a young specimen. The scale formula is as follows: 15 scale-rows; 167 ventrals; a divided anal; about 62 caudals; eye separated from the prefrontals and labials by an ocular ring; loreal and preocular distinct. [A Siamese name for this snake is "ngu hao fai" = fire-hissing snake.—H. M. S.]

PAREAS MOELLENDORFII Boettger

U.S.N.M.		
70357 (S2008)	Lam Tong Lang	July 19, 1925.

In our single specimen the internasals and the prefrontals are abnormally fused together. The frontal is as long as broad. The labials are completely separated from the eye by suboculars, and there is a good-sized postocular. There are seven upper labials, the seventh being the longest. The ventrals are 142 and the subcaudals 36 in number. There are very few Siamese records for this species—one from the mountains of Laos (Mouhot), one from Bangkok (Gyldenstolpe), and one from Bangkok (M. Smith).

AGKISTRODON RHODOSTOMA (Boie)

U.S.N.M.		
70338–9 (S1972–3)	Ban Sadet	May 30, 1925.
72141 (S2508)	Nong Khor	Mar. 20, 1926.
72142 (S2541)	do	Mar. 22, 1926.

TRIMERESURUS GRAMINEUS GRAMINEUS (Shaw)

U.S.N.M.				Internasals	Chin shields	First supralabial fused with nasal	Nasal separated from second supralabial
67517 (S739)	Nontaburi	Nov.	13, 1923	2	2+5 pairs	Yes	Yes
67518 (S936)	Bangkok	Mar.	13, 1923	2	2+5 "	Yes	Yes
70285 (S1833)	"	Mar.	18, 1925	2	2+4 "	Yes	No
70286 (S2086)	"	Aug.	23, 1925	—	2+5 "	——	——
70287 (S2110)	"	Sept.	22, 1925	2	2+4 "	Yes	No
70288 (S2118)	"	Sept.	27, 1925	2	2+4 "	Yes	No
70342 (S2192)	Nong Mong	Aug.	26, 1925	2	2+4 "	Yes	No
70347 (S1961)	Pak Jong	May	18, 1925	2+2 [14]	2+6 "	([15])	No
70350 [16]	"		"				
70351 (S2011)	Lam Tong Lang	July	20, 1925	2	2+5 "	Yes	No
70352 (S2012)	"		"	2	2+5 "	([17])	No
70353	"	July	—, 1925	2	2+5 "	No	Yes
70354	"		"	2+1 [14]	2+6 "	([17])	No
72075 (S2764)	Bangkok	Aug.	5, 1926	2+1 [14]	2+5 "	Yes	Yes
72076 (S2779)	"	Aug.	16, 1926	2	2+5 "	Yes	No
72077 (S2899)	"	Mar.	31, 1926	2	2+4 "	Yes	No
75682 (S3492)	"	Aug.	4, 1927	2+1 [14]	2+5 "	Yes	Yes
76121 (S3934)	"	July	6, 1928	2	2+5 "	Yes	Yes

All the vipers have the two large internasal plates generally in contact with each other, but occasionally separated by one or two small scales. Following the two pairs of enlarged chin shields, there are from four to six quite regular pairs of scales before the first gastrostege is reached.

In all the Bangkok vipers, as well as in the one from Nontaburi, the first supralabial is completely fused with the nasal in front of the nostril.

In the Lam Tong Lang specimens the first supralabial and the nasal are entirely distinct in one case (70353); in two cases the fusion is only partially completed as a trace of the original suture line is still plainly evident (70352 and 70354); in one specimen the fusion is complete (70351). In the snake from Pak Jong (70347) the fusion is complete on the left side of the head, while the right side shows the first supralabial and the nasal plate quite separate from each other.

In 6 out of 18 snakes a small scale is present between the posterior edge of the nasal plate and the second supralabial. The other 12 have the nasal and the second supralabial directly in contact.

[14] Azygous. [15] No on right, yes on left. [16] Embryo of 70347. [17] Partially.

TESTUDINATA

GEOCLEMYS SUBTRIJUGA (Schlegel and Müller)

U.S.N.M.			
70363 (S1689), adult	Bangkok	Jan. 24, 1925.	
71480, half grown	do	Dec. 21, 1925.	
72212 (S2722), adult	Lem Sing	June 14, 1926.	
72322–3 (S1634–5), juvenal.	Bangkok	Nov. 25, 1926.	
75706 (S3742)	do	May 21, 1928.	

The Bangkok specimens were found in the padi fields, where they are called by the natives "tao na" or "field turtle."

HEOSEMYS GRANDIS (Gray)

U.S.N.M.			
71479	Pak Jong	May 13, 1925.	

This turtle, found in a pool at Pak Jong, is called "tao hin" by the natives, meaning "rock turtle."

HOESEMYS SPINOSA (Gray)

U.S.N.M.			
72729 (S3086)	Ronpibun	Jan., 1927.	R. Havmöller.
75584 (S3762)	Pran	June 4, 1928.	

CYCLEMYS DENTATA (Gray)

U.S.N.M.		
67570 (S1043), juvenal	Bangkok	Sept. 12, 1923.
70376 (S2149), juvenal	Nong Khor	Sept. 30, 1925.

At Nong Khor the natives call this turtle "tao bai mai" or "leaf turtle."

BELLIA CRASSICOLIS (Gray)

U.S.N.M.		
70364 (S2164)	Bangkok	Oct. 13, 1925.

This species is called at Bangkok "tao dam," meaning "black turtle."

TESTUDO ELONGATA Blyth

U.S.N.M.		
70365 (S2147), adult	Lam Tong Lang	June 8, 1925.
70366 (S2148), juvenal	Nong Khor	Sept. 24, 1925.
72171 (S2618), juvenal	Pak Jong	May 11, 1926.

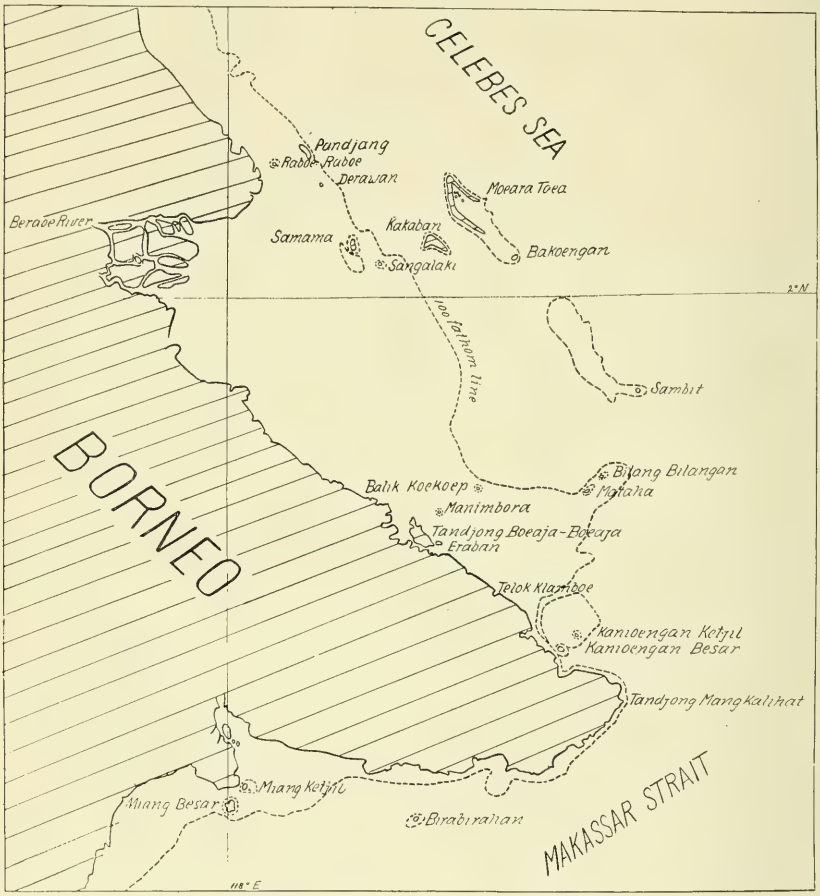
The turtle from Lam Tong Lang was taken in the jungle. The natives of that region call it "tao kipueng" or "wax turtle." At Nong Khor, the native name is "tao kaneng" (kaneng = small, or fragment).

AMYDA CARTILAGINEA (Boddaert)

U.S.N.M.		
72727 (S2605)	Bangkok	Apr. 26, 1926.
72728 (S2607)	do	Sept. 30, 1926.

At Bangkok this soft-shelled turtle is called "tao tapab nam."

U. S. GOVERNMENT PRINTING OFFICE: 1930



MARATUA (MOEARA TOEA) AND ADJACENT ISLANDS

SEE REFERENCES TO LOCALITIES IN TEXT

BIRDS FROM THE SMALL ISLANDS OFF THE NORTHEAST COAST OF DUTCH BORNEO

By J. H. Riley

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Mr. Harry C. Raven, working under the support of Dr. W. L. Abbott for the United States National Museum, visited Dutch northeast Borneo in 1912. After collecting on the mainland in the vicinity of Samarinda from the latter part of May until early July, he sailed north with some Sulu natives to Pulo Derawan. On the first trip they stopped only at the islands of Kaniungan Besar, Derawan, and Maratua; on the latter for the night only. Upon arrival at Derawan, Raven purchased a native prahu and secured a native crew. With them he visited much of the neighboring coast as well as the following islands: Derawan, Pandjang, Raboe Raboe, Maratua, Bakungan, Samama, Sangalaki, Bilang Bilangan, Mataha, Balik Kukup, Marimbora, Eraban, Kaniungan Besar, and Kaniungan Ketjil.

Mr. Raven has sent me the following notes upon the islands visited:

Derawan lies just nine nautical miles east of Tandjong Batoe, which is a long, low point on the mainland of Borneo just north of the Baraoe River. Derawan is a low, sandy island about half a mile in its greatest diameter and is entirely planted with coconuts, most of which were bearing. It has a greater population than any of the other small islands off this part of the Bornean coast. The population consists of Sulu natives and Badjaoe, or seafaring Malay fishermen, in about equal numbers and three or four Chinese traders.

Pulo Pandjang is much larger than Derawan and is seven nautical miles from the nearest point on the coast. It lies eight miles northeast of Tandjong Batoe and four and one-quarter miles northwest of Derawan. It is two and one-half miles in length by about a mile in width and was owned by a Frenchman, who had cleared all the forests in order to plant coconuts. In some places along the shore there still remains a fringe of mangroves. The surface of the island is slightly undulating, though the altitude above high tide is probably nowhere more than 30 feet. The only inhabitants were natives from Derawan and the mainland, employed by the owner.

Between the nearest point on the mainland and Pulo Pandjang lies the little island of Raboe Raboe, which is partly covered with forest and almost entirely

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surrounded by mangrove swamps. One small hill rises about 30 feet above sea level. A family of Malays were living on the island at the time of my visit and were responsible for clearing some of the forest in order to plant coconuts.

The next island to note is Moeara Toea (or Maratua), a large island 28 nautical miles directly east of Tandjong Batoe, which is the nearest point on the mainland. Maratua is a peculiarly shaped island, in the form of a V with the right arm about twice the length of the left and bent inward, so that it forms a rhomb with one side missing. It is about 11 miles in length on the southwestern arm and five on the northeastern side. Unlike the other islands visited, it is not low and sandy but is composed almost entirely of sharp, cavernous rock of a very dark color. This type of rock is called by the Malays "batoe bini," literally, female rock. The only place where this rock was not to be found was a narrow strip near the shore on the southwestern part of the island, where the land was flat and sandy and nowhere more than a few feet above the level of the sea. Here at the time of my visit were a few Bandjerese Malays, who were clearing the forest and planting coconuts for one of the Chinamen of Derawan. The rest of the island was covered with heavy forest. I was told by the natives that there was much hard wood, including ironwood. There were also many large cinnamon trees in this forest and I was presented with several large pieces of the cinnamon bark. In most places in the forest of Maratua no soil was to be seen, nothing but sharp, jagged rock over which the roots of the trees wound as they descended into its holes and crevices. The highest part of the island was about 400 feet.

After spending a few days near the southern tip of Maratua, we managed to work the prahu around into the bay and anchored near five tiny islands, the names of which my crew told me were Semoet, Alanga, Sangalen, Tong Toetoep, and Loesa Koekoep. On one or two of these little islands were groves by which coconut trees had been planted. Badjaoe natives come to the islands occasionally to fish and gather shells.

From Maratua we followed southeastward along the reef to Pulo Bakungan, which is 6 miles from Maratua, the two being connected by a broad reef. Like Maratua, Bakungan is also made of sharp, dark-colored rock, resembling lava, though whether it is or not I do not know. Part of the shore of Bakungan was covered with white coral sand. The vegetation was scrubby and sparse.

I wanted to stop at the island of Kakaban, just 4 miles southwest of Maratua, but was unable to do so at the time, for it offered no shelter for my prahu. The narrow reef about Kakaban affords no protection from the wind and strong current. The island seemed to be of the same sharp rock as that on Maratua.

Pulo Samama lies 16 miles southeast of Tandjong Batoe, nearly 11 miles directly west of Kakaban, and is in line with Derawan and Pandjang to the northwest. The island is about a mile long. From the sea, as we approached, I could see that it was covered with low forest and I was surprised to find Samama to be an atoll, the lagoon of which was filling with mud and sand and a rather dense growth of mangroves. I think no part of the island was more than 2 feet above high-water mark. Samama has no human inhabitants but is occasionally visited by people from Derawan in search of fish and turtle eggs. About Samama there are very extensive reefs, of which some of the coral protrudes at very low tides.

From Pulo Samama we were unable to see toward the southeast the little island of Sangalaki, distant about four and one-half miles. Sangalaki is a beautiful island, low and sandy, covered with forest and surrounded by a wide

reef. It has no human inhabitants. Natives from Derawan sometimes visit the island to collect turtle eggs but otherwise it is seldom visited. Tandjong Batoe is the nearest point on the mainland and it is 22 miles away in a northwesterly direction.

We sailed from Sangalaki for Bilang Bilangan, 46 nautical miles away in a southeasterly direction. After getting out of sight of the island we were becalmed and as the coast is low we could see no land at all. At nightfall I suggested that the natives should row. They replied that if they did, we should pass the islands of Bilang Bilangan and Mataha during the night. They then told me that whenever they were becalmed on their way to gather turtle eggs on these islands, they furled sail, dropped anchor (so that in case they drifted near a reef the anchor would catch before the boat grounded) and went to sleep. When they awakened in the morning they were always in sight of the islands. I followed their advice but we were so many miles away I could scarcely believe that the current alone could carry us so far by morning. However, at daybreak the first thing I heard was an argument among the natives about the names of the two islands in sight. We had been carried about 20 miles during the night by the southeasterly current and were then about 5 miles from Bilang Bilangan, which we reached in an hour.

Bilang Bilangan is 23 miles from the nearest point on the mainland. It is less than a mile long and runs to a point on the northern end. This northern point is covered with grass and bushes but the rest of the island is forested. There are no permanent inhabitants but the natives from Derawan and elsewhere come to gather turtle eggs.

Mataha looked like a very small island from Bilang Bilangan, because it is very narrow and long and from that point only one end of it can be seen. In character the two islands are very much alike, though the forest on Mataha is perhaps a little more dense. Mataha has no permanent inhabitants. It is 2½ miles southwest of Bilang Bilangan and 20 from the mainland.

From Mataha we sailed 16 miles due west to Balik Kukup, a tiny island half a mile or less in length, nearly all of it planted with coconuts of which many were bearing. There were a few big forest trees at one end of the island and some dense growth beneath them. The inhabitants of Balik Kukup were all Badjaoe (seafaring Malays) and related to natives of Tandjong Boeaja Boeaja and Samoentai on the nearby mainland. Balik Kukup is just 10½ miles from the mainland.

After staying a short time at Balik Kukup, we sailed to Manimbora, an island even smaller than the one we had left, and located 6½ miles southwest of that island. Manimbora is covered with coconut trees in bearing. It had been used for a great many years as a burial ground for natives of the whole region. In fact, my boys told me than they could seldom dig a grave without unearthing the bones of a former burial.

Eraban is a small island four miles due south from Manimbora. Part of it had been for many years planted with coconut trees. The whole island is very low and almost surrounded by mangrove swamps, which almost connect it with the larger island of Tandjong Boeaja Boeaja.

Following the coast southeasterly for 24 miles, we reached the island of Kanioengan Besar, somewhat over a mile from the mainland. It was planted with coconuts and had a village populated with seafaring Malays.

Three miles northeast of Kanioengan Besar is the tiny island Kanioengan Ketjil, on which there is no vegetation except coarse grasses and little vines or creepers.

Of the islands here considered, all are within the 100-fathom line, except Maratua and Kakaban, which appear to be volcanic. These two islands are beyond the Sunda Shelf. Of the islands connected by shallow water with the mainland of Borneo, all appeared to me to be built up from coral reefs, except Pulo Pandjang and Pulo Raboe Raboe. On these two islands there were deep yellow or golden-colored soils in places, much resembling those of the nearby mainland of Borneo.

It was the original intention to have Dr. Harry C. Oberholser work up the Bornean collection as a whole, in conjunction with collections previously made in that general area by Dr. W. L. Abbott, but owing to his other duties progress in this has been slow. In view of his preoccupation in other matters I have been requested to report on the birds collected by Raven on the smaller islands separately. In a preliminary paper [1] I have named one form from Maratua and two forms occurring on Maratua as well as some of the other small islands of this part of the Bornean coast. Of all the islands visited Maratua is the only one that has developed a more or less peculiar avifauna. This is not remarkable, as it is the only island of any size amongst those visited by Raven and lies outside the Sunda Shelf.

Doctor Oberholser had used Raven's material in revisionary work or the description of new forms, but in the case of the kingfishers of the genus *Sauropatis* [2] the names of the small islands in the bay at Maratua were used and their connection with that island lost or buried.

The present paper contains a list of all the birds collected by Raven on these small Bornean islands. Outside of the novelties found on Maratua there are several records of forms that have never been taken on the main island of Borneo before to my knowledge.

All measurements in this paper are in millimeters.

I am indebted to Mr. Raven for making the map to accompany this article.

Family MEGAPODIIDAE

MEGAPODES

1. MEGAPODIUS CUMINGII TOLUTILIS Bangs and Peters

Megapodius cumingii tolutilis BANGS and PETERS, Occasional Papers Boston Soc. Nat. Hist., vol. 5, 1927, p. 235 (Maratua).

One adult female, Pulo Maratua, (Alanga), May 11.

In color the above specimen closely resembles the single specimen of *Megapodius cumingii gilbertii* from Celebes, available for com-

[1] Proc. Biol. Soc. Washington, vol. 40, 1927, pp. 139–141.

[2] Proc. U. S. Nat. Mus., vol. 55, 1919, pp. 351–395.

parison, but is considerably larger. The Maratua specimen measures: wing, 225; tail, 71; culmen, 18; tarsus, 66; middle-toe, 45. The single specimen of *M. c. gilbertii* (a male): wing, 195; tail, 67.5; culmen, 16; tarsus, 60; middle-toe, 40.

When writing on the birds of Celebes I had to examine the birds from the Philippines to determine what name to use for the Celebes bird. Some notes were given as well as the measurements of all the specimens of the species available to me at that time.[3] There seems to be more than one form in the Philippines but what names to use for them, I can not settle with the material at my command. The specimens from Palawan are smaller and lighter than those from the other Philippine Islands, and these I have regarded as representing *Megapodius cumingii*, until material from northwest Borneo is available for comparison. Bangs and Peters[4] say that Sharpe fixed the type of *Megapodius cumingii* Dillwyn upon the Philippines, but they overlooked Tweeddale's remarks,[5] which show that Dillwyn's description and plate were founded upon a Labuan specimen and that he named the Philippine form, *Megapodius dillwyni*, the type being one of Cuming's specimens; the only specimens of Cuming listed in the Catalogue of Birds British Museum[6] come from Luzon and I would definitely fix this as the type locality. The specimens from Luzon and the northern islands are large and dark. In the same article cited above, on a previous page, Tweeddale proposed *Megapodius pusillus*, founded upon a young specimen from Cebu; this is indeterminable until adult specimens have been examined. *Megapodius forsteni balukensis* Oberholser[7] was founded upon a single adult female from Baluk Baluk Island, off Basilan, Philippines. It is a dark bird somewhat darker than the Luzon bird and measures: wing, 230; tail, 77; culmen, 18.5; tarsus, 61.5; middle-toe, 40.

The specimen of *Megapodius cumingii tolutilis* is more of a cinnamon-brown and not so dark below as the type of *M. f. balukensis;* the former has the wing coverts the same color as the back while in the latter they are chaetura drab.

From the above it will be readily seen there is considerable confustion in regard to the number of forms in the Philippines; a confusion that can only be unraveled by a study of much larger series than are available in American museums at present.

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[3] Proc. U. S. Nat. Mus., vol. 64, art. 16, 1924, pp. 6–7.
[4] Occasional Papers, Boston Soc. Nat. Hist., vol. 5, p. 236.
[5] Proc. Zool. Soc. London, 1877, p. 766.
[6] Vol. 22, 1893, p. 450.
[7] Journ. Washington Acad. Sci., vol. 14, 1924, p. 294.

Family TRERONIDAE

FRUIT PIGEONS

2. DENDROPHASSA VERNANS PURPUREA (Gmelin)

Columba purpurea GMELIN, Sys. Nat., vol. 1, pt. 2, 1789, p. 784 (Java).

Two males, Pulo Maratua (Semut), May 10.

These seem to agree with specimens from eastern Borneo, which in turn do not seem to differ materially from males from Java.

3. HAEMATAENA MELANOCEPHALA BANGUEYENSIS (Meyer)

Ptilopus bangueyensis MEYER, Journ. für Orn., 1891, p. 70 (Banguey).

One male, Pulo Pandjang, May 2.

This specimen agrees fairly well with three males of *H. m. bangueyensis* from Mindanao; the crissum appears to be a little darker yellow and the longer under tail-coverts are a trifle deeper red, that is all; the wing a little longer.

The United States National Museum does not contain a specimen from Banguey, but does possess a male from Cagayan Sulu; an island in the Sulu Sea to the eastward. This specimen has been made the type of *Haemataena melanocephala enantia*,[8] but the characters upon which it is founded are very slight.

H. m. melanospila from Celebes is smaller and the throat and crissum a deeper yellow than *H. m. bangueyensis*. The Pandjang specimen agrees with Celebes specimens in the color of the crissum, but with those from Mindanao in the color of the throat, and in size is even slightly larger.

The present form does not seem to have been recorded so far south before.

4. MUSCADIVORES PICKERINGII PICKERINGII (Cassin)

Carpophaga pickeringii CASSIN, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, 1855, p. 228 (Mangsi, Sooloo Ids.).

Four males and two females, Pulo Sangalaki, May 26 and 28; one male, Pulo Maratua, August 28; one female, Pulo Bakungan, May 17; six males and four females, Pulo Bilang Bilangan, May 30–June 3.

There does not appear to be any difference between the specimens from the various islands listed above. Compared with the type of *pickeringii* and a female from Cagayan Sulu the above series seems to average a little lighter on the mantle and back, but the series of *pickeringii* is so small it would be unsafe to separate them. As far as the material before me goes, *pickeringii* is divisible into three forms as follows:

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[8] Oberholser, Journ. Washington Acad. Sci., vol. 14, 1924, p. 296.

1. *Muscadivores pickeringii pickeringii* (Cassin). Sulu Islands and the coast of north Borneo.

2. *Muscadivores pickeringii langhornei* Mearns. East and West Bolod, and Loran Island, near Basilan, Philippines. Lighter on the mantle and back than *pickeringii.*

3. *Muscadivores pickeringii palmasensis* Mearns. Palmas Island, east of Mindanao, Philippines. Darker on the mantle and back than *pickeringii.*

There seems to be little or no constant difference in size between the races.

An immature male from Bilang Bilangan (No. 182279) has a considerable number of the wing-coverts drab at the tips; the forehead and throat are extensively white; the under tail coverts fawn color; and the breast and head much less tinged with vinaceous. A female from the same locality approaches it, but is nearer the adult plumage. Specimens showing an approach to the above characters are probably birds of the year, the adult having the chin and throat narrowly white, the under tail coverts drab gray, the head and chest washed with pale vinaceous drab, and the wing coverts dark olive gray without drab tips.

5. MYRISTICIVORA BICOLOR (Scopoli)

Columba bicolor Scopoli, Del. Flor. et Faun. Insubr., pt. 2, 1786, p. 94 (New Guinea).

One male, Pulo Sangalaki, May 28; 2 males, Pulo Maratua, August 28; 11 males and 2 females, Pulo Bilang Bilangan, May 30–June 3.

One male, Bilang Bilangan (No. 182256), has the under tail coverts with rather large, round, subterminal black spots; the outer tail feather with the black border at the tip barely indicated and dusky rather than black; and the back and wing coverts pallid neutral gray. Evidently a bird of the year.

Judging from the above, the apparently adult specimens with the under tail coverts tipped with black are younger than those with entirely white under tail coverts.

Family COLUMBIDAE

PIGEONS and DOVES

6. COLUMBA GRISEOGULARIS (Walden and Layard)

Ianthoenas griseogularis Walden and Layard, Ibis, 1872, p. 104, pl. 6 (Guimaras, Philippines).

One male, Pulo Bilang Bilangen, May 31.

There seems to be no constant difference between the above male and specimens from the Philippines. It measures: Wing, 226; tail, 135; culmen from cere, 13.

7. CALOENAS NICOBARICA (Linnaeus)

Columba nicobarica LINNAEUS, Sys. Nat., ed. 10, 1758, p. 164 (Nicobar Islands).

One female, Pulo Maratua (a captive bird brought to Borneo from the above island, July 6; in rather bad plumage).

Family CHARADRIIDAE

PLOVERS

8. CHARADRIUS LESCHENAULTII Lesson

Charadrius leschenaultii LESSON, Dict. Sci. Nat. (Levrault), vol. 42, 1826, p. 36 (Pondicherry, India).

One female, Pulo Bakungan, May 17.

9. CHARADRIUS MONGOLUS Pallas

Charadrius mongolus PALLAS, Reise Russ. Reichs, vol. 3, 1776, p. 700 (Mongolia).

One male, Pulo Bakungan, May 17.

Family ARDEIDAE

HERONS

10. TYPHON SUMATRANUS SUMATRANUS (Raffles)

Ardea sumatrana RAFFLES, Trans. Linn. Soc. London, vol. 13, pt. 2, 1822, p. 325 (Sumatra).

One immature female, Pulo Derawan, July 23.

11. DEMIGRETTA SACRA (Gmelin)

Ardea sacra GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 640 (Tahiti).

Two males, two females, and one unsexed, Pulo Derawan, July 24; one female, Pulo Bakungan, May 17; two males and two females, Pulo Maratua, May 12 and 20; two males and five females, Pulo Kaniungan Ketchil, April 3.

Six of the above are adults in the dark phase; two immature in the dark phase; nine adults and immatures in the white phase.

Two immature birds in the white phase are acquiring a few dark centered feathers and evidently would eventually have acquired a dark plumage.

While the United States National Museum contains a good series of this species, it lacks good material from the southern part of its range, and I am unable, for the present, to ascertain the forms, if any, into which it is divisible.

Four adult males (dark phase) from islands off northeast Borneo measure: Wing, 282–295 (287); tail, 94–98 (96.4); culmen, 83–87 (85); tarsus, 81–83 (81.9); middle toe, 54–55 (54.5). Two adult females (dark phase): Wing, 272–275; tail, 84.5–90; culmen, 78–79; tarsus, 69–74.5; middle toe, 48–50.5.

12. BUTORIDES JAVANICUS JAVANICUS (Horsfield)

Ardea javanica HORSFIELD, Trans. Linn. Soc. London, vol. 13, 1821, p. 190 (Java).

Butorides javanicus carcinophonus OBERHOLSER, Journ. Washington Acad. Sci., vol. 14, 1924, p. 294 (Pulo Alanga, eastern Borneo).

One female, Pulo Alanga, Maratua, May 12.

The above specimen is the type of *Butorides javanicus carcinophonus* (quoted above). It is subadult: the sides of the neck hair brown and the wing coverts edged with cinnamon buff. There is a slightly younger specimen in the United States National Museum (No. 181669) from east Borneo that matches it in the color of the sides of the neck, and another from Palawan (No. 160977). I believe this indicates that the Maratua bird is not fully adult.

There is not enough material of this species in the National Museum at present to work out the forms. There is a fair series from the Philippines, but from the rest of the range the material is deficient. Two specimens from Java, marked male and female, but both probably females, agree in size and color with a small series of five males and one female from Celebes. The series from the Philippines agrees with that of Celebes in size. The Philippine bird has been separated as *Butorides javanicus carcinophilus*,[9] but it seems to me, without examining more material than at present available, that the grounds for its separation are not sufficient.

Four adult males and one female from south China (Shanghai, Nanking, and N. W. Yunnan) are considerably larger than any from the Philippines, Celebes, or Java and, if this difference would hold in a larger series, should probably be recognized as a good race.

While there are no specimens in the National Museum that match the type of *B. j. carcinophonus*, I believe this is due to the paucity of the material rather than to a real difference; otherwise the form would have another one occurring on three sides and almost surrounding it, a possibility hardly probable in this class of birds.

The various series measure as follows:

	Wing	Culmen
4 males, South China	183 –198 (188. 5)	61– 67. 5 (64. 9)
8 males, Philippines	164 –174 (165. 6)	60– 63 (61. 9)
5 males, Celebes	170 –176 (173. 8)	57 –63 (59. 6)
1 female, South China	187. 5	63
1 female, Tonking	181	66
2 females, Java	163 –163	62. 5–63
9 females, Philippines	162. 5–175 (167. 7)	57. 5–63 (61)
1 female, Maratua	168. 5	65

[9] Oberholser. Journ. Washington Acad. Sci., vol. 14, 1924, p. 294.

Family FREGATIDAE

MAN-O'-WAR BIRDS

13. FREGATA ARIEL ARIEL (Gray)

Atagen ariel GRAY, Genera Birds, vol. 3, 1845, p. 669 (Raine Island, N. Australia).

One male and two females, Pulo Samama, April 22.

There is not enough material in the United States National Museum to correctly determine the forms of this species. A male from Celebes previously reported upon[10] is quite different from the Bornean male. The Celebes specimen is bluish green on the mantle with purplish reflections in certain lights and bronzy green on the lesser wing coverts, while the Samama bird is a dull black with a band of violet across the middle of the feathers of the mantle, the lesser wing coverts just dull black with a very faint bronzy tinge, hardly noticeable. The Celebes bird is in fresher, less worn plumage.

The two females are in quite distinct plumages. One with the head dusky black, the crown with a rusty tinge; the throat hair brown with some rusty feathers on the lower border; the chest and upper breast white; lower breast and belly dusky black; a light collar around hind neck. The other female from Samama has the head and throat white, with a few rusty feathers here and there; the chest hair brown, shading off into dusky black on the upper breast; the lower breast and belly white. The white-headed bird is in more worn plumage than the black-headed one. There is a difference in the color of the bills between the two also. The black-headed specimen has the base of the bill a dull pompeian red, only the nail at the tip horn color; while in the white-headed bird the bill is clay color, only the tip horn color.

The bills measure as follows: Male, 89; black-headed female, 88; white-headed female, 82; the male from Celebes, 90.

Family FALCONIDAE

HAWKS, EAGLES, ETC.

14. CUNCUMA LEUCOGASTER (Gmelin)

Falco leucogaster GMELIN, Syst. Nat., vol. 1, pt. 1, 1788, p. 257 (unknown; fixed by Mathews as New South Wales).

One adult male, Pulo Bilang Bilangan, May 30. Wing, 535; tail, 230; culmen from cere, 41. The measurement of the wing is much smaller than that given by Swann.[11] It may be that the species breaks up into several forms, but the material available is not sufficient to go into the matter. Mathews[12] gives three races for the area covered by his book alone.

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[10] Proc. U. S. Nat. Mus., vol. 64 art 16, 1924, p. 36.

[11] Syn. Accipitres, pt. 3, 1922, p. 143.

[12] Sys. Av. Austral., pt. 1, 1927, pp. 254–255.

Family PSITTACIDAE

PARROTS

15. TANYGNATHUS LUCIONENSIS HORRISONUS Bangs and Peters

Tanygnathus lucionensis horrisonus BANGS and PETERS, Occasional Papers of the Boston Soc. Nat. Hist., vol. 5, 1927, p. 235 (Maratua).

Three males and one female, Pulo Maratua, May 9–21.

The difference in size between this form and *T. l. lucionensis* is not great; *T. l. horrisonus* appears to have the subterminal black on the middle wing coverts more extensive. One of the males is much worn and not fully adult; the other two measure: Wing, 193–202; tail, 135–136; culmen from cere, 31–32. The female: Wing, 195; tail, 120; culmen from cere, 31.

16. LORICULUS GALGULUS GALGULUS (Linnaeus)

Psittacus galgulus LINNAEUS, Syst. Nat., ed. 10, 1758, p. 103 (India; type locality fixed by Hartert[13] as: Malay Peninsula, Malacca).

One immature male, Pulo Derawan, July 23; two adult males, and one female, Pulo Eraban, June 12 and 13.

The above apparently do not differ materially from specimens from the mainland or the main island of Borneo. The two males measure: Wing, 80–83; tail, 33–36; culmen from cere 11–11.5.

Family ALCEDINIDAE

KINGFISHERS

17. SAUROPATIS CHLORIS CYANESCENS Oberholser

Sauropatis chloris cyanescens OBERHOLSER, Proc. U. S. Nat. Mus., vol. 52, 1917, p. 189 (Pulo Taya, southeast Sumatra).

A large series, consisting of adults of both sexes and immatures, from the following islands: Pulo Raboe Raboe, May 4 and July 27; Pulo Derawan, July 22 and 23; Pulo Samama, April 21; Pulo Sangalaki, May 26 and 27; Pulo Maratua (including the small islands in the bay: Sangalen, Lusa Kukup, and Alanga), May 12–24; Pulo Bakungan, May 17; Pulo Bilang Bilangan, May 30–June 1; Pulo Mataha, June 5; Pulo Balik Kukup, June 9–10.

Doctor Oberholser has already used part of the above specimens in his revision of this species.[14]

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[13] Nov. Zool., vol. 9, 1902, p. 542.

[14] Proc. U. S. Nat. Mus., vol. 55, 1919, pp. 351–395.

Family MICROPODIDAE

SWIFTS

18. COLLOCALIA VESTITA MARATUA Riley

Collocalia vestita maratua RILEY, Proc. Biol. Soc. Washington, vol. 40, 1927, p. 141 (Maratua).

One adult male (the type), Pulo Maratua, May 21.

This specimen is similar to *Collocalia vestita mearnsi* of the Philippines but the upper parts are deeper black, less sooty; the wings showing a more purplish sheen, less greenish; the lower parts much duskier. Wing, 118; tail, 48.

While the present form was founded upon one specimen only, I had before me 14 specimens of *Collocalia vestita mearnsi* and 4 of *Collocalia vestita vestita.* From the former it differs as described, from the latter it may be told by the fact that it is a much deeper, less brownish, black above, the wings and tail more purplish, less greenish, but below the two forms are much alike. *Collocalia vestita aenigma* of Celebes resembles *Collocalia vestita maratua* above, but is lighter below, especially on the throat, and has a somewhat longer wing.

It would appear as though the birds of this genus are not great wanderers, but are more or less sedentary.

19. COLLOCALIA FRANCICA PERPLEXA Riley

Collocalia francica perplexa RILEY, Proc. Biol. Soc. Washington, vol. 40, 1927, p. 140 (Maratua).

Eight males, three females, and one unsexed, Pulo Maratua, May 21 and 24; one male and one female, Pulo Pandjang, May 2; one female Pulo Balik Kukup, June 10; one female, Pulo Raboe Raboe, July 27.

The above series is similar to *Collocalia francica germani* of Siam and the Philippines, but the wing averages longer, the back is a deeper, less brownish, black, the rump band much darker and much less pronounced, the wings and tail with more purplish and less greenish sheen. The present specimens have been compared with about an equal number from Peninsular Siam and the Philippines. There do not appear to be any differences in size and color between the sexes. The nine males from islands off northeast Borneo have wings, 119.5–125 (121.8); eight males from Peninsular Siam (4) and the Philippines (4) have wings, 109–122 (117.3). Apparently no form of *Collocalia francica* has been recorded from Borneo before. *Collocalia francica bartelsi* Stresemann[15] from west Java is not available for examination, but the distribution of the forms is now

[15] Orn. Monatsb., 1927, p. 46.

known to be more circumscribed than formerly supposed, and the form from northeast Borneo and the form from west Java will hardly prove to be the same.

Family CUCULIDAE

CUCKOOS

20. CHALCITES MALAYANUS MALAYANUS (Raffles)

Cuculus malayanus RAFFLES, Trans. Linn. Soc. London, vol. 13, pt. 2, 1822, p. 286 (Malay Penin.).

Two males, Pulo Pandjang, May 2.

These measure: Wing, 90–93; tail, 61–61; culmen, 14–15.

Family PICIDAE

WOODPECKERS

21. YUNGIPICUS MOLUCCENSIS TANTULUS Riley

Yungipicus moluccensis tantulus RILEY, Proc. Biol. Soc. Washington, vol. 40, 1927, p. 140 (Tangguroeng, Mahakkam River, N. E. Borneo).

One male and one female, Pulo Pandjang, May 2 and 3; one female, Pulo Eraban, June 12.

Hargitt [16] has shown that the name of this species should be *Yungipicus moluccensis* (Gmelin) and that the type locality is probably Java. Two males and a female before me from Java are darker above than the Bornean birds listed above; the Javan specimens have the nasal plumes and a loreal streak creamy white, while in the Bornean specimens the loreal streak is much reduced and the nasal plumes are the color of the forehead; the upper tail coverts in the Bornean birds are less heavily barred, and they average smaller. A male in the collection from the Mahakkam River, northeast Borneo, does not appear to differ from the three from the islands off the coast. The female of this species seems to be as large or larger than the males.

Two males and one female from Java, measure: Wing, 73–75 (74.3); culmen, 13–14.5 (13.8).

Two males and two females from northeast Borneo and islands off coast, measure: Wing, 66.5–74 (69.7); culmen, 12–14.5 (13).

22. DINOPIUM RAVENI Riley

Dinopium raveni RILEY, Proc. Biol. Soc. Washington, vol. 40, 1927, p. 139 (Pulo Eraban, northeast Borneo).

One adult male (the type) and one adule female, Pulo Eraban, June 13.

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[16] Ibis, 1882, p. 43.

Similar to *Dinopium javanensis javanensis*, but wing and tail much shorter and the feathers of the center of the chest and breast buffy brown with rather narrow cream buff centers without any black.

Adult male.—Pileum scarlet, the feathers blackish basally; a superciliary stripe, running from about the middle of the eye back on to the sides of the neck buffy white, bordered above anteriorly with black; rictal streak buffy white; ear-coverts black; malar stripe black; mantle and wing-coverts pyrite yellow, the feathers of the mantle fringed with light cadmium; lower back and rump chaetura drab broadly tipped with scarlet; upper tail coverts chaetura black; tail black; throat buffy white with a few small black spots down the center; jugulum buffy brown, the feathers with buffy white centers and a few of them with a blackish mark at the tip, but hardly forming a band; center of the chest and breast buffy brown, the feathers with rather narrow buffy white centers; belly buffy white, the feathers barred rather obscurely and narrowly with buffy brown; under tail coverts buffy white barred rather narrowly with chaetura drab; sides and flanks buffy white barred rather narrowly with black; primaries fuscous black with oval white spots on the inner web; secondaries fuscous-black, the outer web broadly pyrite yellow, the inner web with oval white spots. Wing, 123; tail, 71; culmen 30.5.

Adult female.—Like the male, except the pileum is black with narrow white shaft streaks. Wing, 126; tail, 79; culmen, 28.5.

In a large series of *Dinopium javanensis* from different parts of the range of the species there are none that match the above specimens; all have the feathers of the chest and breast heavily bordered with black. *Dinopium raveni* has a proportionally shorter wing tip than *Dinopium javanensis* and for this reason, along with the distinct color of the chest, must be ranked as a distinct species. *Dinopium javanensis* has been recorded from Borneo. *Tiga borneonensis* Dubois [17] was described from an unknown locality in Borneo as having the lower-parts transversely barred with black and can not very well be the present species. Hartert writes [18] that it is only an abberrant *Tiga javanensis*, but Dubois [19] dissents from this disposition of his species and points out that he had a pair. Dubois [20] had previously published a plate of the types, and they certainly look quite different from anything represented in the series of the United States National Museum. Aberrations are not likely to occur in pairs and it is quite likely that *Tiga borneonensis* will be rediscovered.

[17] Proc. Zool. Soc. London, 1897, p. 782.
[18] Nov. Zool., 1901, p. 50.
[19] Ornis, vol. 14, 1907, pp. 43 and 521.
[20] Syn. Av., fasc. 1, 1899, pl. 1.

To *Dinopium everetti* of the Palawan group of islands in the Philippines, *Dinopium raveni* bears a certain resemblance, but the latter is smaller, lacks the black barring on the breast, the throat is buffy-white instead of cinnamon, the chest buffy brown with buffy-white shaft streaks instead of cinnamon without shaft streaks; in the male, the malar stripe is without any red, and there are other differences.

Dinopium raveni is hardly confined to Eraban, an island that is separated from the main island of Borneo only at high tide, but the short wing-tip seems to indicate that it is more or less local.

Since writing the above, I have discovered an additional female of *Dinopium raveni* in the National Museum that was overlooked. It is from Tanjong Batoe, northeast Dutch Borneo, collected August 25, and is No. 181,841. The feathers of the chest are lighter than in the Pulo Eraban specimen, more of a wood brown, each feather lighter in the center and narrowly fringed with dusky at the tip and with two incipient bars separated by the lighter center along the shaft; the breast and abdomen yellowish white, washed with wood brown, each feather with one or more subterminal bars of dusky; on the middle of the breast there is a single yellowish white feather crossed by two subterminal blackish bars; otherwise it is much like the Eraban specimen. It measures: Wing, 119; tail, 81; culmen, 26.5.

Family MUSCICAPIDAE

FLYCATCHERS

23. CYORNIS BECCARIANA BECCARIANA (Salvadori)

Siphia beccariana Salvadori, Atti R. Acad. Torino, vol. 3, 1868, p. 533 (Sarawak).

One adult female and one immature female, Pulo Raboe Raboe, May 4 and July 27.

Raven took two adult males on the opposite shores of the main island of Borneo (Segah River and Sungei Ritan). The female from Raboe Raboe, belongs without much doubt, to the same form as the males.

The above female from Raboe Raboe is indigo blue above from the bill to and including the tail and the outer aspect of the closed wing; the lores whitish; the auriculars bluish black; below ochraceous-orange, belly whitish. The males are indulin blue on the head shading off into dusky blue on the back, or, in some positions, even eton blue, especially on the rump.

From the above it will be seen that the female is only a duller, duskier blue above than the male.

The immature female listed above resembles the adult female, except it still retains a few rufous spotted feathers of the immature dress on the forehead, sides of head, and mantle.

The adult female from Raboe Raboe measures: Wing, 73; culmen, 14.

24. GERYGONE SALVADORII Büttikofer

Gerygone salvadorii Büttikofer, Notes from the Leyden Mus., vol. 15, 1893, p. 175 (southern Borneo).

One male and one female, Pulo Raboe Raboe, May 4 and July 27; two males and one female Pulo Samama, April 22.

No additional specimens from Borneo of this rare form are available for comparison, but they seem to agree with the original description and the measurements are about the same as given there. The white spot on the inner web of the outer tail feathers near the tip is well marked on the three outer and occurs on the fourth as a mere dot.

25. HYPOTHYMIS AERIA Bangs and Peters

Hypothymis aeria Bangs and Peters, Occasional Papers of the Boston Soc. Nat. Hist., vol. 5, 1927, p. 237 (Maratua).

Seven adult males, one immature male, and four adult females, Pulo Maratua, May 9-20.

Three males and two females of the above series come from the small islets of Alanga and Sangalan in the bay at the north end of Maratua.

This very distinct species needs no comparison. Judging from descriptions, it seems to be an approach towards *Hypothymis rowleyi*, which is not available for comparison. In two of the above males of *H. aeria*, the black jugular collar is very faint, practically absent; and in the majority of the males the occiput is darker than the crown, but not black.

26. HYPOTHYMIS AZUREA PROPHATA Oberholser

Hypothymis azurea prophata Oberholser, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 597 (Great Karimon Island).

One female, Pulo Miang Besar, September 10.

This specimen is lighter on the back and head and the tail is more tinged with bluish than in a female from Banka. The Miang Besar specimen measures: Wing, 67.5; tail, 66; culmen, 13.

27. RHIPIDURA JAVANICA JAVANICA (Sparrman)

Muscicapa javanica Sparrman, Mus. Carls., fasc. 3, 1788, pl. 75 (Java).

One male, Pulo Raboe Raboe, May 4; two males and one female, Pulo Derawan, July 23–25; one female, Pulo Eraban, June 13.

The above small series agrees with a small series from the main island of Borneo. An adult male from Java has the top of the head much less deeply black (more of a chaetura black) than Bornean males and the back is also lighter.

Family CAMPEPHAGIDAE

CATERPILLAR SHRIKES

28. LALAGE NIGER MITIFICA Bangs

Lalage niger mitifica BANGS, Bull. Mus. Comp. Zoölogy, vol. 45, No. 4, 1922, p. 80 (Lubang, near Luzon, Philippines).

One male and one female, Pulo Derawan, July 26; one female, Pulo Samama, April 21; one immature male, Pulo Maratua, May 21; one male, Pulo Bakungan, May 18; five adult males, five immature males, five females, and one unsexed, Pulo Bilang Bilangan, May 30–June 3.

The adults of the above series do not appear to differ appreciably from Philippine specimens; in size the Bornean island birds are a trifle smaller, but the difference is not great enough to distinguish by name. Seven males from islands off northeast Borneo measure: Wing, 88–93 (91); tail, 65–70 (68.2); culmen, 14.5–16 (15.2). Six males from the Philippines: Wing, 92.5–96 (94.2); tail, 67–72.5 (69.6); culmen, 14.5–16 (15.2).

Family PYCNONOTIDAE

BULBULS

29. AEGITHINA TIPHIA ZOPHONOTA Oberholser

Aegithina tiphia zophonota OBERHOLSER, Smithsonian Misc. Coll., vol. 76, No. 6, 1923, p. 8 (Laham, east-central Borneo).

Three adult females and one immature (sex?), Pulo Eraban, June 12 and 13.

These agree with the form occurring on the opposite shore of Borneo. The three measure: Wing, 57.5–61 (58.8); tail, 44–46.5 (44.8); culmen, 14.5–15 (14.7). Doctor Oberholser, in the paper cited above, gives a synopsis of the forms of the species as worked out by him.

30. BRACHYPODIUS HODIERNUS (Bangs and Peters)

Microtarsus hodiernus BANGS and PETERS, Occasional Papers of the Boston Soc. of Nat. Hist., vol. 5, 1927, p. 238 (Maratua).

One adult female, Pulo Maratua, May 16.

This specimen agrees with the original description, except the colors of the head are reversed, purplish reflections above and

greenish on the throat; only the outer tail feather is slate color below, the others show some blackish near the middle, increasing inwardly towards the central pair. It measures: Wing, 81; tail, 74; culmen, 13.5.

31. PYCNONOTUS GOIAVIER ANALIS (Horsfield)

Turdus analis Horsfield, Trans. Linn. Soc. London, vol. 13, 1821, p. 147 (Java).

Three males, two females, and one nestling, Pulo Derawan, July 26.

These agree with Java specimens in color and measurements. Birds from the opposite shores of Borneo do not appear to differ from those from Derawan. The three males from Derawan measure: Wing, 86.5–90 (88.3); tail, 79–83 (80.3); culmen 17–17.5 (17.3), and the two females, wing, 84–85; tail, 74.5–75.5; culmen, 16.5–17.

Family TURDIDAE

THRUSHES

32. COPSYCHUS NIGER Ramsay

Copsychus niger Ramsay, Proc. Zool. Soc. London, 1886, p. 123 (Elopura, N. E. Borneo).

One female, Pulo Raboe Raboe, May 4.

This specimen measures: Wing, 102; tail, 87; culmen, 22.

The United States National Museum contains three forms or species of black-bellied *Copsychus* from Borneo, as follows:

(1) A wholly black bird with a black tail; only a mere trace of white on the outer web of the outer tail feather near the base and a white dot on the outer web of the two outer feathers at the tip; the under tail coverts wholly black. *Copsychus niger.*

(2) A black bird with the two outer tail feathers white except at the extreme base and the third outer tail feather white, black only basally and in a narrow border on the inner edge of the inner web; the under tail coverts black with white centers. *Copsychus amoenus.*

(3) A black bird like the last; only the outer tail feather white, except the extreme base, the second tail feather bordered with black on the inner web, the third tail feather with only a triangular white spot at the tip; the under tail coverts white and the lower belly and flanks mixed white and black.

Hartert[21] says no. 3 is unnamed. All three forms have white lesser wing coverts, in nos. 2 and 3 even extending on to the outer web of the inner secondaries.

Copsychus niger has a longer bill than *C. amoenus;* otherwise the two species are much alike, except for the white outer tail feathers, the white edging on outer web of the inner secondaries, and

[21] Nov. Zool., vol. 17, 1910, p. 235.

the white centers to the under tail coverts of the latter. *Copsychus amoenus* is very close to No. 3, but lacks the white under tail coverts and the white mixture on the lower belly and flanks of the latter and the tail pattern is different.

Of *Copsychus amoenus* the United States National Museum has six males and five females from southeast and north central Borneo, but of the other two only a pair of each. The male of *Copsychus niger* is from Sandakan and the female as listed above. The pair of No. 3 are from Kina Balu. *Copsychus saularis musicus* or a similar form also occurs in Borneo. It has the whole belly white.

Stresemann[22] has attempted to explain the differences between *Copsychus saularis musicus* and *Copsychus amoenus* on the grounds of mutation, but not very successfully, it seems to me. He does not mention *Copsychus niger* in the article.

33. KITTACINCLA BARBOURI Bangs and Peters

Kittacincla barbouri Bangs and Peters, Occasional Papers of the Boston Soc. Nat. Hist., vol. 5, 1927, p. 239 (Maratua).

One male, Pulo Maratua, May 10.

The above specimen agrees with the original description. It measures: Wing, 104; tail, 128; culmen, 17. A male of *K. stricklandi* before me, measures: Wing, 94.5; tail, 103; culmen, 17.

Family ARTAMIDAE

WOOD SWALLOWS

34. ARTAMUS LEUCORYNCHUS LEUCORYNCHUS (Linnaeus)

Lanius leucorynchus Linnaeus, Mantissa, 1771, p. 524 (Manila).

Two males and two females, Pulo Raboe Raboe, May 6 and July 27; one male, Pulo Samama, April 22; two males, Pulo Maratua (Sangalan and Lusa Kukup), May 13 and 15. These agree with a series from the Philippines in size and color.

Family LANIIDAE

SHRIKES

35. MUSCITREA GRISOLA SECEDENS (Stresemann)

Pachycephala grisola secedens Stresemann, Nov. Zool., vol. 20, 1913, p. 335 (Sirhassen).

Four males and three females, Pulo Maratua, May 9–16; two males, Pulo Pandjang, May 2; two females, Pulo Raboe Raboe, July 27.

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[22] Journ. für Orn., 1924, pp. 252–255.

This series compared with *Muscitrea grisola grisola* of the mainland averages browner on the head and has a larger, heavier bill; below, the gray of the chest comes down further and the white of the belly is more restricted. The only two specimens examined from Java are very pale, paler than either *M. g. grisola* or *M. g. secedens* and evidently represent another form. One of the males from Pandjang is very much worn, the other five males measure: Wing, 82–87.5 (85); tail, 60.5–67.5 (63.8); culmen, 15–16 (15.5). Five males of *M. g. grisola* measure: Wing, 82–87 (83.9); tail, 58–61 (59.3); culmen, 13–15 (13.9).

Family SITTIDAE

NUTHATCHES

36. CALLISITTA CORALLIPES (Sharpe)

Dendrophila corallipes SHARPE, Ibis, 1888, p. 479 (Mount Kina Balu, Borneo).

Two males and two females, Pulo Eraban, June 12.

These are considerably lighter above and below than the only specimen available from Borneo, an unsexed female without definite locality, for comparison. I am of the opinion that only one of the specimens from Eraban is fully adult. It is a male and measures: Wing, 76; culmen, 14.5.

Family NECTARINIIDAE

SUNBIRDS

37. CHALCOSTETHA CALCOSTETHA PROXIMA Riley

Chalcostetha calcostetha proxima RILEY, Proc Biol. Soc. Washington, vol. 40, 1927, p. 141 (Pulo Derawan, northeast Borneo).

Over 90 specimens were collected, consisting of adults of both sexes and immatures, from the following islands: Raboe Raboe, May 4, 6, and July 27; Derawan, April 25–28 and July 22–25; Samama, April 21, 22; Maratua, May 11–20; and Bakungan, May 17, 18. No constant differences in color can be detected between series from the main island of Borneo and the small islands off the coast, but the island series average larger, especially the culmen. Thirty males from the small islands given above measure: Wing, 59–65 (62.3) culmen, 18.5–21 (19.5). Six males from northeast Borneo measure: Wing, 58–62.5 (60.5); culmen, 17.5–19 (18.2). Males from the Malay Peninsula agree with those from the main island of Borneo in size, as the following will show: Seven males, wing, 60–61.5 (61); culmen, 17–19.5 (18). The males from northeast Borneo and the islands off the coast run remarkably true to type. The lower back, rump, and upper tail coverts are a shining coppery green with little

or no iridescent lilac purple. On the mainland the majority of the males have these parts with much iridescent lilac purple, but some have these parts green with little or no lilac. The most brilliantly green-rumped specimens examined are a male from West Sumatra and one from Java. Stuart Baker[23] restricts the type locality of *Nectarinia calcostetha* Jardine to Borneo.

38. AETHOPYGA SIPARAJA OCHROPYRRHA Oberholser

Aethopyga siparaja ochropyrrha OBERHOLSER, Bull. U. S. Nat. Mus., No. 98, 1917, p. 65 (Pulo Rittan, Anamba Islands).

One adult male and one immature male (marked female), Pulo Raboe Raboe, May 4 and 6.

The adult male agrees fairly well with a series, consisting of four males, from the opposite shores of the main island of Borneo; it is a little more yellowish citrine on the belly, the edges of the remiges are amber brown rather than raw sienna and the reds a little darker. The series from the main island of Borneo is very close to males from the Karimata Islands that have been assigned by Doctor Oberholser[24] to the Anamba Island form; the reds in the Karimata specimens are just a trifle darker than in the Bornean males. The Raboe Raboe male is like the Karimata bird in the tone of the reds, but it is more yellowish citrine on the belly and the edges of the remiges are deeper in color. The four males from Borneo measure: Wing, 49–51 (49.6); culmen, 15–15.5 (15.2). The Raboe Raboe male: Wing, 50; culmen, 16. Two males from the Karimata Islands: Wing, 51.5–54; culmen, 16–16.

39. LEPTOCOMA SPERATA (Linnaeus)

Certhia sperata LINNAEUS, Syst. Nat., ed. 12, 1766, p. 186 (Philippines).

Three males, Pulo Maratua, May 13–21.

These three males are very close to specimens from the Philippines; they seem to have a little smaller wing and bill and the belly is not quite so yellow. The three measure: Wing, 47.5–48.5 (48); culmen, 13.5–14.5 (14). Ten adult males selected at random from a series from the Philippines measure: Wing 49–52 (50); culmen, 14–15.5 (15).

40. ANTHREPTES MALACENSIS BORNENSIS Riley

Anthreptes malacensis bornensis RILEY, Proc. Biol. Soc. Washington, vol. 33, 1920, p. 55 (Po Bui Island, Sandakan, British North Borneo).

One adult male, one immature male, and three females, Pulo Raboe Raboe, May 4 and July 27; two adult males, one immature male, and three females, Pulo Pandjang, May 2; one adult male and one fe-

[23] Fauna Brit. India, Birds, vol. 3, ed. 2, 1926, p. 373.
[24] Proc. U. S. Nat. Mus., vol. 64, Art. 22, 1924, p. 4.

male, Pulo Samama, April 21 and 22; five adult males, one immature male, and seven females, Pulo Derawan, April 25 and July 22–26; three adult males and one female, Pulo Eraban, June 12 and 13; one adult male, Pulo Miang Besar, September 10.

The specimens from the northern islands of the group, Raboe Raboe, Pandjang, Samama, and Derawan, seem to agree with specimens from north Borneo. The birds from Eraban and Miang Besar are somewhat smaller, especially the bill, and the cheeks are olivaceous with little or no reddish wash. Specimens from the Mahakkam River region are smaller than typical north Bornean birds and the cheeks are more olivaceous with little or no reddish wash. With the latter the Eraban specimens agree in size and color, which is only natural, Eraban being only a little more northern and barely separated from the main island at high tide.

The average measurements in millimeters of the males of the above series are as follows:

	Wing	Tail	Culmen
10 males, north Borneo	68. 2	47. 7	18
8 males, Derawan and adjacent islands	67. 9	46. 4	17. 8
7 males, east central Borneo	66. 9	43. 9	16. 8
4 males, Eraban and Miang Besar	65. 4	43	16. 7

41. ANTHREPTES MALACENSIS MJOBERGI Bangs and Peters

Anthreptes malacensis mjobergi Bangs and Peters, Occasional Papers Boston Soc. Nat. Hist., vol. 5, 1927, p. 240 (Maratua).

Three males and five females, Pulo Maratua, May 13–24; one male and two females, Pulo Bakungan, May 18.

This form is not so well differentiated from typical *A. m. bornensis* from north Borneo as the original description would lead one to infer. It averages slightly larger but the cheeks and postocular region are hardly more reddish. The male from Bakungan has a slightly smaller bill, but seems to agree, otherwise, with this form. Two of the males from Maratua are in rather worn plumage and the measurements are smaller than those given by the original describers. The four males measure: Wing 67.5–72 (69.5); tail, 45–47 (46); culmen, 17.5–19 (18.5).

Family GRACULIDAE

GLOSSY STARLINGS

42. LAMPROCORAX PANAYENSIS ALIPODIS Oberholser

Lamprocorax panayensis alipodis Oberholser, Journ. Wash. Acad. Sci., vol. 16 1926, p. 516 (Pulo Pandjang, Borneo).

Aplonis panayenis suggrandis Bangs and Peters, Occasional Papers Boston Soc. Nat. Hist., vol. 5, 1927, p. 241 (Maratua).

Two males and two females, Pulo Pandjang, May 2; one male, Pulo Derawan, July 26; two males, Pulo Maratua, May 13–24.

All the above appear to belong to one form. *L. p. alipodis* is intermediate between *L. p. panayensis* of the Philippines and *L. p. neglectus* of Celebes, but in color nearer the latter; it is somewhat larger than either. The difference is not great, however. The five males measure: Wing, 110–115.5 (113); tail, 73–82.5 (77.7); culmen, 19–21.5 (20.5). Ten males of *L. p. neglectus:* Wing, 106–112.5 (109.2); tail, 71–77.5 (74); culmen, 19–22 (20.5). *L. p. panayensis* is of about the same size as *L. p. neglectus* but it is a brighter, more coppery green above. *L. p. alipodis* is duller above possibly even than *L. p. neglectus*, but the difference is very slight.

Family ORIOLIDAE

ORIOLES

43. ORIOLUS XANTHORNUS TANAKAE Kuroda

Oriolus xanthornus tanakae Kuroda, Tori, vol. 4, No. 19, 1925, p. 3 (Tawao, Brit. N. Borneo).

One adult male and one adult female, Pulo Raboe Raboe, May 6 and July 27; one adult male and one adult female, Pulo Eraban, June 12.

The principal difference between this form and *Oriolus xanthornus xanthornus* is the much smaller size of *tanakae;* the two males of the latter measure: Wing, 128–130; tail, 75.5–77; culmen, 28–28.5. The two males have no yellow at the tips of the primaries, but the female has a slight yellow margin at the tip from the fifth inwards. Otherwise the female is much like the male, except there is more black in the tail, the black beginning on the fourth feather instead of the fifth.

U. S. GOVERNMENT PRINTING OFFICE: 1930

SOME PECULIAR SPIRAL FOSSIL FORMS FROM CALIFORNIA AND MEXICO

By Wendell C. Mansfield

Of the United States Geological Survey

In 1927 I described some peculiar fossil forms from the Miocene (?) of Maryland.[1] Subsequent to the publication of that paper Dr. Bruce L. Clark, of the University of California, Berkeley, Calif., sent me specimens of similar fossil forms from California and Mexico, and he has kindly permitted me to describe them.

The Maryland specimens are spiral, nearly straight, and irregular objects, probably representing the remains of organisms. They were obtained from the low bluffs along the western shore of Chesapeake Bay, St. Marys County, Md. For the spiral form I proposed a new generic name, *Xenohelix*, and designated *Xenohelix marylandica* Mansfield as the genotype. I said that I had not formulated any particular theory to explain the origin of the coiled or uncoiled forms. I also mentioned that if these forms owe their origin to some organism, as they probably do, that of some marine plant, perhaps a fucoid, seems the more likely. I have obtained no additional information to explain the origin either of the Maryland specimens or the specimens described in this paper. Neither do I know that the specimens obtained in so widely separated areas have the same origin.

DESCRIPTION OF TWO NEW SPECIES

I have placed the following two new species provisionally under the genus *Xenohelix*, although they may have no generic relationship to the Maryland form.

XENOHELIX? CLARKI, new species

Plate 1, Figure 1

The specimen selected as the holotype is incomplete, the whorls at either extremity having been broken away. It consists of four

[1] U. S. Nat. Mus. Proc., vol. 71, No. 2688, art. 16, 1927.

symmetrically and regularly coiled, equally spaced, and equally sized whorls. The outline of the tube in cross section is elliptical. No demarcation is observed in cross section to indicate a peripheral wall distinct from a central core. The material composing the tube appears to be the same as that of the surrounding matrix. A petrographic analysis [2] of the material of the tube shows that it consists of fine-grained sand cemented with calcium carbonate and that the dominant minerals present are calcite, quartz, feldspar, and biotite.

Xenohelix? clarki apparently differs from *Xenohelix marylandica* Mansfield in lacking, in cross section, two distinct parts—the peripheral wall and the central core. The species is named in honor of Dr. Bruce L. Clark.

Dimensions.—Holotype (Cat. No. 371106, U.S.N.M.); Length, 74 millimeters; diameter, 42 millimeters; maximum diameter of tube, 18 millimeters.

The coils of another specimen (pl. 2, figs. 1, 2) obtained at the same locality are more drawn out than those of the holotype.

Occurrence.—Pine Canyon, Contra Costa County, Calif. Doctor Clark informs me that both specimens were collected near the top of the Monterey group at a horizon which he considers equivalent to the "Temblor," in the middle part of the State, and are associated with a marine middle Miocene fauna which includes such species as *Bruclarkia stanfordensis* (Arnold), *Arca devincta* Conrad, *Macoma*, new species, *Pecten* cf. *perrini* Arnold, and several other species.

XENOHELIX? MEXICANA, new species

Plate 1, Figures 2, 3

The specimen selected as the holotype is incomplete, the whorls at either extremity having been broken away. The specimen consists of three symmetrically and regularly coiled, equally spaced, and equally sized whorls. The outline of the tube in cross section is elliptical, being broadly angled at the periphery. Obscure spiral raised lines occur near the periphery of the whorls. The material composing the tube consists of ferruginous fine-grained sand and small mica flakes and the surrounding matrix consists of dark-colored shale containing particles of carbonaceous matter.

Dimensions.—Holotype (Cat. No. 371107, U.S.N.M.): Length, 36 millimeters; diameter, 25 millimeters; maximum diameter of tube, 11 millimeters.

Occurrence.—The label accompanying the specimens gives the following information: "Black shales probably from the base of the *Exogyra costata* horizon [Cretaceous]. Lower beds on top of Sierra de la Azufrosa on boundary line of Haciendas Mesillas and Azufrosa,

[2] Analysis made by C. S. Ross, of the section of petrology, U. S. Geological Survey.

southeast of Monument 19, municipality of Ramos Arizpe, State of Coahuila, Mexico. Collected by P. D. Krynine." Other smaller specimens from the same locality are like the holotype except that their diameters are proportionately somewhat greater.

DESCRIPTION OF PLATES

PLATE 1

FIG. 1. *Xenohelix? clarki* Mansfield, holotype (×1), p. 1.
FIGS. 2, 3. (*Xenohelix? mexicana* Mansfield, holotype (×2), p. 2.
Fig. 2, end view. Fig. 3, side view.

PLATE 2

FIGS. 1, 2. *Xenohelix? clarki* Mansfield, paratype (×1), p. 1.
Fig. 1, side view. Fig. 2, end view of same specimen.

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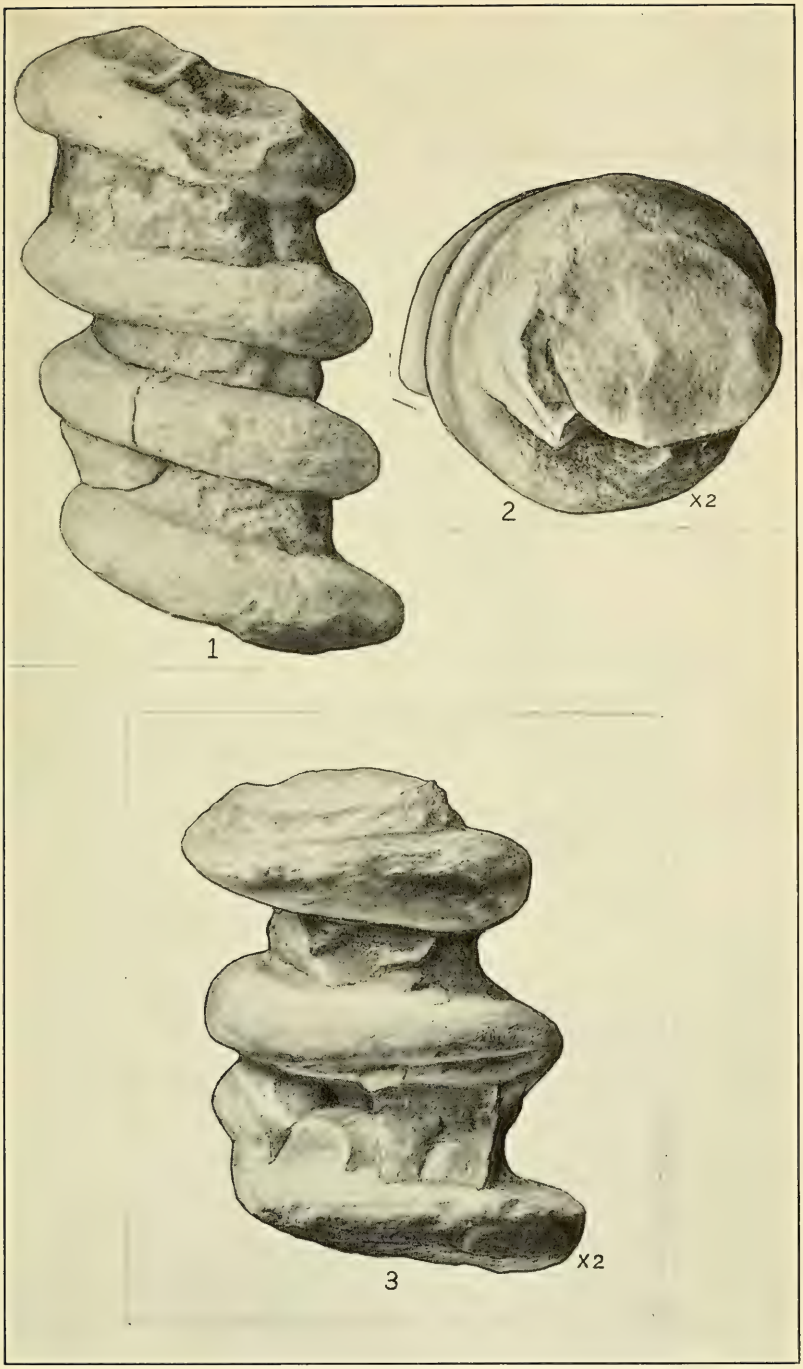
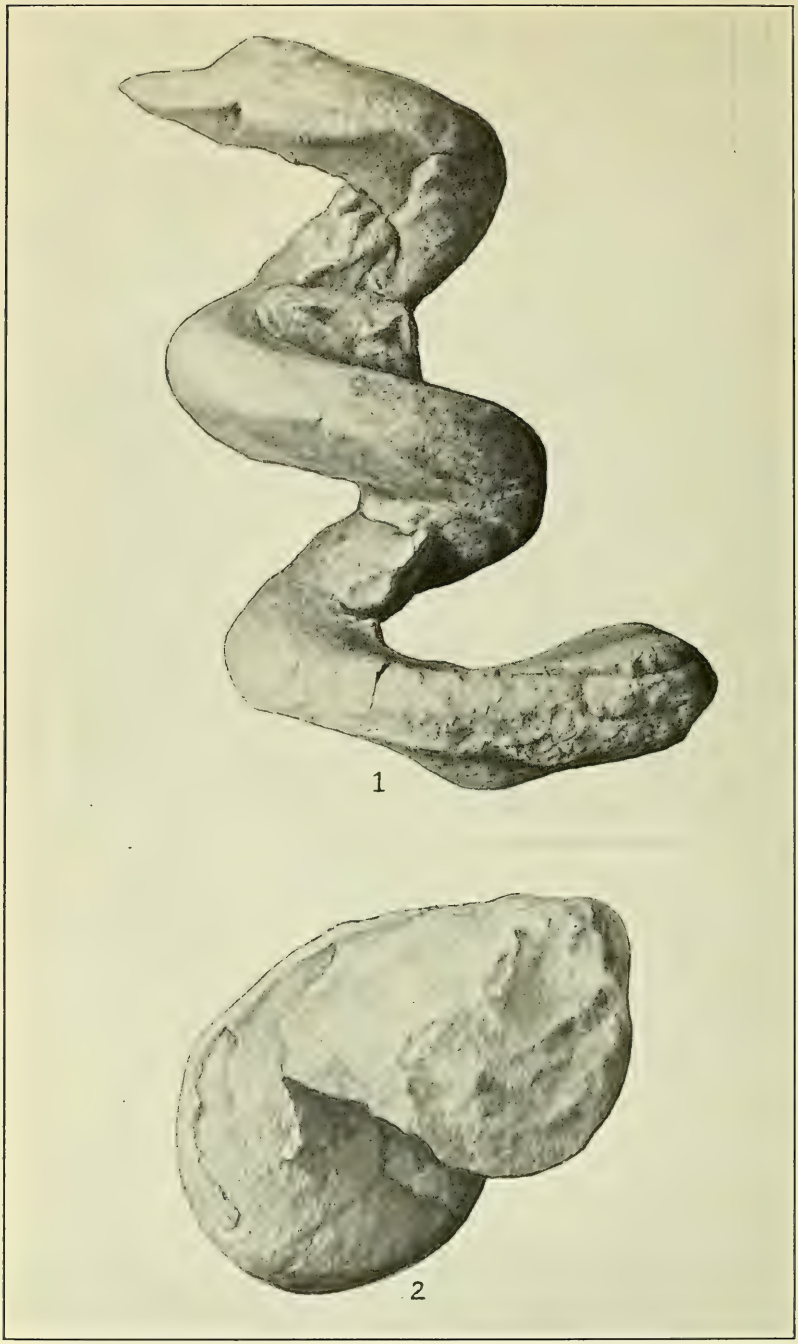


PECULIAR SPIRAL FOSSIL FORMS FROM CALIFORNIA AND MEXICO

FOR EXPLANATION OF PLATE SEE PAGE 3.



PECULIAR SPIRAL FOSSIL FORM FROM CALIFORNIA

FOR EXPLANATION OF PLATE SEE PAGE 3.

NEW FORMS OF SPHECOID WASPS OF THE GENUS DIDINEIS WESMAEL

By J. R. Malloch

Biologist, Bureau of the Biological Survey

and

S. A. Rohwer

Assistant Chief, Plant Quarantine and Control Administration, Department of Agriculture

The present paper contains a revision of the North American species of the genus *Didineis* Wesmael, with descriptions of two new species and one new variety.

Genus DIDINEIS Wesmael

Didineis Wesmael, Revue Critique, 1851, p. 96.—Kohl, Ann. k. k. Hofmus. Wien, vol. 11, 1896, p. 402.—Fox, Ent. News, vol. 5, 1894, p. 126.

Kohl considers the genus *Didineis* as a subgenus of *Alyson* Jurine, but with the striking differences in the venation of the fore and hind wings (figs. 1, 2), together with the differences that seem to exist in the genitalia (figs. 3, 4), it would be desirable to recognize it as a genus, which has been done by many European and most American workers.

Fox tabulated the American species in 1894. Since that time three new species have been described, and in the collections of the United States National Museum there are representatives of two additional new species and a new variety. To make it easier to recognize these forms we have prepared the following key, which includes all the North American species; but the species marked with an asterisk is placed entirely on description.

KEY TO THE NORTH AMERICAN SPECIES OF DIDINEIS

1.	Females	2.
	Males	6.
2.	Thorax and abdomen reddish-brown	3.
	Thorax and part of the abdomen black	4.
3.	Head black	stevensi Rohwer.
	Head pale	peculiaris Fox.
4.	Apical tergites black	*sanctacrucae Bradley.
	Abdomen entirely rufous	5.

5. Frons shining, with small distinct punctures which are separated by a distance as great as, or greater than, the width of a puncture; third antennal segment distinctly longer than twice the length of second, and distinctly longer than fourth; posterior face of propodeum coarsely reticulate; apex of pygidium rounded; apical margin of clypeus yellow--texana (Cresson).
   Frons dull, with close distinct punctures, the distance between them seldom as great as the width of a puncture; third antennal segment about twice as long as second, and but little longer than fourth; posterior face of propodeum granular, and with irregular wrinkles; apex of pygidium subtruncate; clypeus black----------latimana, new species.
6. Anterior tarsi much widened; anterior femora thin and concave on anterior side beneath; basal segments of antennal flagellum nodose beneath; head at least partly yellow or reddish----------7.
   Anterior tarsi not flattened; anterior femora more or less cylindrical, not concave beneath; basal segments of antennal flagellum simple; head black----------texana (Cresson).
7. Fore tibiae deep black except at apices, highly polished on ventral or inner surfaces, and about as wide as widest portion of fore tarsus (fig. 7), the ventral surface hollowed out; scape of antennae entirely fulvous yellow----------dilata, new species.
   Fore tibiae entirely testaceous yellow, or infuscated above, and not as wide as widest part of fore tarsus, the ventral or inner surface convex; scape of antennae blackened on one side, yellow on the other----------8.
8. Fore femur not much produced downward at middle, extreme height at middle much less than half as great as its entire length (fig. 5); sides of face usually without a yellow line----------latimana, new species.
   Fore femur much produced downward at, or beyond, middle, greatest height equal to, or over, half as long as entire length (fig. 6); face entirely or partly pale----------9.
9. Reddish brown species, apex of abdomen black; fore femur highest at apical third----------peculiaris Fox.
   Black species, with portions of the head and abdomen reddish or yellowish----------10.
10. Head ferrugineous except for a black transverse band on vertex extending from eye to eye and enclosing the ocelli----------vierecki Rohwer.
   Head mostly black----------11.
11. Clypeus largely black, yellow along the lower margin----------nodosa Fox.
   Clypeus entirely yellow----------nodosa var. clypeata, new variety

DIDINEIS STEVENSI Rohwer

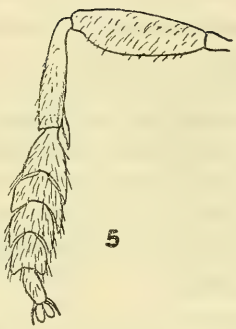
Didineis stevensi Rohwer, Proc. Ent. Soc. Washington, vol. 25, 1923, No. 4, p. 98.

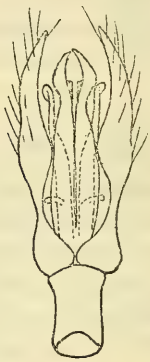
This species is known only from a single female collected at Sheldon, N. Dak.

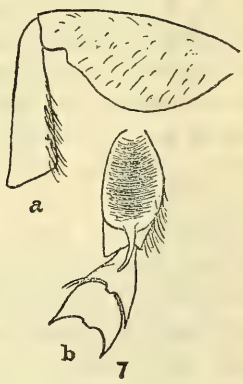
DIDINEIS PECULIARIS Fox

Didineis peculiaris Fox, Ent. News, vol. 5, 1894, p. 128.

This species was described from a number of males and females collected in Montana. As Bradley pointed out, the fore tarsi and femora of this species are peculiarly modified so it belongs to a group of males related to *nodosa*, but may be readily separated in both sexes







FIGURES 1–8.—ALYSON SP., HIND WING. 2, DIDINEIS NODOSA, HIND WING. 3, ALYSON SP., MALE HYPOPYGIUM. 4, DIDINEIS NODOSA, MALE HYPOPYGIUM. 5, D. LATIMANA, FORELEG FROM BEHIND. 6, D. NODOSA, FORELEG FROM BEHIND. 7, D. DILATA, *a*, FORE FEMUR AND TIBIA FROM BEHIND, *b*, FORE TIBIA AND BASAL TWO SEGMENTS OF FORE TARSUS FROM BELOW (INSIDE), 8, D. NODOSA, ANTENNA OF MALE

by the ferrugineous color. The anterior femora of the male are thin, concave beneath and produced ventrally as in *nodosa* except that they are widest in the apical third, where the width is about one-half the length of the femur. The anterior tarsi are flattened and resemble very closely those of *nodosa*.

DIDINEIS SANCTACRUCAE Bradley

Didineis sanctacrucae BRADLEY, Trans. Amer. Ent. Soc., vol. 46, No. 801, 1920, p. 129.

This species is unknown to us except through the description. The types are in Cornell University. Bradley suggests that these may be the female of *nodosa*, and it is very probable that this association is correct.

DIDINEIS TEXANA (Cresson)

Alyson texana CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1873, p. 226.

The type of this species is in the United States National Museum. It was originally described from a single male from Texas. There are specimens before us from Texas, Pennsylvania, District of Columbia, St. Augustine, Fla. (April 20, 1919, C. W. Johnson), Columbus, Ohio (July 15, 1921, A. E. Miller), St. Louis, Mo. (Rau No. 2633), and Tifton, Ga.

DIDINEIS LATIMANA, new species

Male.—Length, 6–8 mm. Black, shining. Under side of scape, the nodes of the swollen segments of flagellum, fore tibia except on dorsum, and most of fore tarsi lemon yellow; mid and hind femora and tibiae fulvous, more or less suffused with fuscous, tarsi of same legs fuscous, paler at bases. Sides of face opposite bases of antennae with or without a yellowish mark; posterior lobe of prothorax in front of and below wing base faintly fulvous. Abdomen with basal two tergites more or less red. Preapical dark band on forewing rather faint.

Antenna as in Figure 8; front very finely and closely punctured; prothorax punctured like front, more coarsely on sides except at lower portion where it is impunctate and glossy; mesonotum with fine close punctures; scutellum devoid of punctures in middle; enclosure of propodeum elongate U-shaped, its basal width over half its greatest length, the surface with a more or less complete central carina and three or four diverging carina on each side of it which are more or less connected by weaker rugae; laterad of the enclosure there are numerous fine rugae which are almost transverse, and the posterior face is finely rugoso-reticulate; mesopleura and sides of propodeum finely rugoso-punctate. Basal sternite coarsely longi-

tudinally striate. Fore legs as in Figure 5; the fore coxae not appreciably flattened in front. Other legs and venation of wings normal.

Female.—Length, 8 mm. Clypeus convex, the apical margin depressed and strongly tridentate, the teeth of equal width and length; the distance between the inner margins of the antennal fossae slightly less than the distance between the outer margin and inner margin of the eye; frons with close, distinct punctures; vertex with the punctures slightly more separated than those on the frons; postocellar line distinctly shorter than ocellocular line; pronotum and mesoscutum with distinct punctures which are separated by a distance less than the width of the punctures; scutellum punctured similarly to the mesoscutum except medianly, where the punctures are very widely separated; propodeum with the enclosure sharply defined and terminating almost at the transverse carina which separates the posterior and dorsal aspects; the surface of the enclosure with irregular wrinkles basally, separsely coriaceous apically; the sides of the dorsal aspect finely, obliquely, irregularly wrinkled. Mesepisternum closely punctured and ventrally with irregular wrinkles so as to appear striato-punctate; the dorsal plate of the episternum opaque and punctured throughout; sides of the propodeum obliquely striato-punctate. Abdomen shining, pygidium sharply defined, the apical margin subtruncate, the surface covered with dense yellowish bristles. Black; mandibles, except apices, scape beneath yellowish; palpi pale brown; tarsi obscurely ferrugineous; intermediate femora and posterior tibiae beneath piceous; posterior femora dark rufous; abdomen entirely rufous; wings dusky hyaline with the usual infuscated area in the radial cell and across the wing. Venation pale brown.

Type locality.—Glen Echo, Md.

Allotype locality.—Millville, N. J.

Paratype localities.—Falls Church, Va., and northern Illinois.

Type.—Cat. No. 29369, U.S.N.M.

Described from two males (one type) from the type locality collected August 30, 1923, by J. R. Malloch; one female (allotype) collected August 6, 1916, by E. R. Kalmbach; one male (paratype) collected at Falls Church, Va., September 4, 1915, by C. T. Greene; and one female (paratype) from northern Illinois.

The male specimen from Falls Church has the basal abdominal segments entirely rufous and the tip of the abdomen paler than in the other two males. The female of this species closely resembles *texana* but it is larger and the head and thorax are more closely punctured, while the propodeum is less coarsely sculptured.

DIDINEIS NODOSA Fox

Didineis nodosa Fox, Ent. News, vol. 5, 1894, p. 127.

Originally described from Washington State. We have four males from Oregon, one from Dallas, one from Corvallis, and two without definite locality; also two males from California (C. F. Baker).

One Oregon specimen lacks the yellow mark on the prothoracic tubercles.

DIDINEIS NODOSA var. CLYPEATA, new variety

Male.—Length, 7 mm. Differs from *nodosa* Fox in having the clypeus entirely yellow instead of with the upper half or more black. The enclosure of the propodeum is also much more closely and finely rugose. The mesepisternum is more shining and more distinctly striato-punctate. In the structure of the fore legs there is no difference from that of *nodosa*, the coxae being flattened in front, and the femora scooped out on anterior side and very much produced downward at middle.

Type locality.—Colorado (C. F. Baker).

Type.—Cat. No. 29370, U.S.N.M.

DIDINEIS VIERECKI Rohwer

Didineis viereckl Rohwer, Proc. Ent. Soc. Washington, vol. 13, 1911, (1), p. 4.

The original description of this species is far from complete in so far as the characters we use in the present paper are concerned, but Dr. H. B. Hungerford has kindly supplied us with information as to the structure of the forelegs of the type specimen in the collection of Kansas University which permits us to place it in our key to the species.

It was originally described from Kansas as *crassicornis* by Viereck, but the name was preoccupied and the above change proposed as indicated.

We have not seen the species.

DIDINEIS DILATA, new species

Male.—Similar in general coloration and structure to *latimana*, but the scape of antennae entirely fulvous yellow, legs of that color but the femora blackened at bases and apices, the fore pair narrowly so and with irregular marks on anterior side, fore tibiae glossy black except at extreme apices, mid and hind tibiae and tarsi brownish black, some portions irregularly paler.

Structurally this species is very similar to *latimana*, but the concave underside of the much wider fore tibia (fig. 7), and slightly

different form of the fore femur serve as good distinguishing features.

Length, 7 mm.

Type locality.—Columbus, Wis.

Type.—Cat. No. 42759, U.S.N.M.

Described from one male, Columbus, Wis., August 23, 1927, on alfalfa (E. M. Searls).

BIRDS COLLECTED IN INNER MONGOLIA, KANSU, AND CHIHLI BY THE NATIONAL GEOGRAPHIC SOCIETY'S CENTRAL-CHINA EXPEDITION UNDER THE DIRECTION OF F. R. WULSIN

By J. H. Riley

Assistant Curator, Division of Birds, United States National Museum

In 1922, Mr. F. R. Wulsin went to China to conduct an expedition for the National Geographic Society to study the native non-Chinese peoples in the western and central parts of the Republic. Selecting Kansu as the objective of his first expedition, Mr. Wulsin started from Paotow (railhead), Inner Mongolia, March 26th, and went westward along the base of the Lang Shan Mountains, thence turned southward through Alashan and crossed the Holanshan Mountains into the irrigated plain of Ninghsia in northeastern Kansu. He then went westward and south to Lanchowfu, which was used as a base for further explorations of the Province. In late July, he followed up the Sining River to Sining, crossed the border into Tibet, and spent August 13–14 on the southeast corner of Lake Kokonor. Returning then to Sining, he went southward to Labrang and on to Choni and the Min Shan range, which is on the boundary between southwest Kansu and northwest Szechwan. He then returned to Lanchowfu by a more direct route to the eastward and in early October went down the Yellow River to Paotow and back to Peking.

Mr. Wulsin has furnished the following notes upon the country traversed:

The first region to be considered in Inner Mongolia was the route westward along the base of the Lang Shan range. The region traversed was a plain fairly well watered in its eastern part, desert towards the west. At T'a Shui K'su, the first trading station in Alashan, the drainage basin of the southern Gobi is encountered, and with it a different fauna. A sandy desert extends south to Wang Yeh Fu, an oasis in the Alashan desert, where birds are numerous, attracted by the water and the crops. The next region to be considered is the Holanshan Mountains and Kansu. The irrigated plain, which lies between Ninghsia and Chung Wei, on the west bank of the Yellow River, is one

No. 2838.—Proceedings U. S. National Museum, Vol. 77, Art. 15
2600—30——1

of the richest areas in the Province of Kansu. At the time of the visit of the expedition in early June it was alive with birds of various kinds.

Between Chung Wei and Lanchowfu the country is a semidesert, first of sand and beyond I Teow Shan of dry earth and loess, almost entirely void of wild life.

Lanchowfu is the natural base of operations for all but the extreme edge of the Province of Kansu. It lies on the Yellow River in a small fertile plain, which is the first hospitable region to greet the traveler who approaches from the north. It is poor, however, in bird and mammal life.

The next region visited was the Tibetan border. Zoologically it falls into two parts: (1) The high rolling plateau of grassland, which makes up most of the Kokonor territory, and (2) the transition belt of mountains, wooded gulleys, and little agricultural settlements, which separate the grassland from Chinese loess country farther eastward. Birds and small mammals are abundant in both types of country. Our march through the country was rapid and the collection obtained, while varied, does not do full justice to the richness of the region.

The last district we visited, and in many ways the most interesting was the range of mountains which lies south of the Tao River and forms the boundary between Kansu and Szechwan. This range, the Minshan, runs east and west. It is very high and rugged and has an abundant rainfall. Tibetan villages exist in some of the valleys. Small mammals and birds are abundant. It would repay intensive collecting over a long period of time.[1]

Though its principal activities were in another field, the expedition brought back an important collection of birds, including 502 specimens, from Inner Mongolia and Kansu, the skins having been prepared by a native collector. Apparently no new birds are in the collection, as a number of explorers have more or less thoroughly covered this country ornithologically, especially the Russians, beginning with Przewalski. The present list, however, adds definitely to the knowledge of the geographic distribution of forms in a region none too well known.

While in Peking, packing up and making preparations for further explorations, Wulsin's collector made a small collection of 147 skins at the Eastern Tombs, about 80 miles northeast of Peking, in the autumn and winter. These it is thought advisable to include in this report, as the wildness of this region is being largely destroyed and a record of the bird life, fragmentary as it is may prove useful in the future.

All of the above material has been generously presented to the United States National Museum by the National Geographic Society. It forms an important addition to our series and will prove of the greatest usefulness, particularly since the Museum had little material from Inner Mongolia or Kansu. While, as mentioned, none of the forms secured is apparently new to science, many of them are extremely interesting and were not hitherto represented in our series.

[1] Also consult: The Road to Wong Ye Fu, by Frederick R. Wulsin. National Geographic Magazine, vol. 49, 1926, pp. 197–234.

They supplement admirably collections previously received from Szechwan and Yunnan.

I am indebted to the authorities of the Museum of Comparative Zoölogy for the loan of a series of *Prunella fulvescens nadiae* Bangs and Peters.

All measurements in this paper are in millimeters.

Family PHALACROCORACIDAE

CORMORANTS

1. PHALACROCORAX CARBO SINENSIS (Shaw and Nodder)

Pelecanus sinensis SHAW AND NODDER, Nat. Miscel., vol. 13, 1802, p. 529 (China).

One adult male, 157 miles west-northwest of Paotow, Inner Mongolia, April 9; 1 immature male and 1 immature female, Choni, Kansu, August 30; 2 immature males, southeast corner of Lake Kokonor, Tibet, August 14.

In recent years I have been identifying all specimens of this species received by the Museum from China as of this form, but am not convinced that I am correct in doing so. An adult female from Yunnan and an adult female from Amoy are somewhat smaller than adult specimens from western Szechwan. There may be a southern and northern race in China, but the series at my command is too small to determine the matter. The above specimens from Mongolia and Tibet agree fairly well with the Szechwan series.

The immature male from Choni is a native skin, and there is some doubt as to the correctness of the locality.

Family ARDEIDAE

HERONS

2. ARDEA CINEREA RECTIROSTRIS Gould

Ardea rectirostris GOULD, Proc. Zool. Soc. London, 1843, p. 22 (New South Wales, error).[2]

One adult male, 1 immature male (barely feathered), and 2 immature females, 60–80 miles south-southwest of Ninghsia, June 8 and 9; 1 immature female, 40 miles south of Lanchow, Kansu, July 14.

3. IXOBRYCHUS SINENSIS SINENSIS (Gmelin)

Ardea sinensis GMELIN, Sys. Nat., vol. 1, pt. 2, 1789, p. 642 (China).

One male, Peking, Chihli, August 11.

[2] Type in the Academy of Natural Sciences of Philadelphia from South India. See Stone, Austral. Av. Rec., vol. 1, 1913, p. 142.

Family ANATIDAE

GEESE AND DUCKS

4. ANSER ANSER (Linnaeus)

Anas anser LINNAEUS, Syst. Nat., ed. 10, 1758, p. 123 (Sweden).

One female, 157 miles west-northwest of Paotow, Inner Mongolia, April 8.

5. EULABEIA INDICA (Latham)

Anas indica LATHAM, Ind. Orn., vol. 2, 1790, p. 839 (India).

One male, 60 miles west of Sining, Kansu (southeast corner of Lake Kokonor, Tibet), August 14.

6. CYGNOPSIS CYGNOIDES (Linnaeus)

Anas cygnoid. LINNAEUS, Sys. Nat., ed. 10, 1758, p. 122 (Asia).

One female, 157 miles west-northwest of Patow, Inner Mongolia. April 10.

This specimen is smaller and lighter in color above, almost lacks the rusty white frontal band, the flanks are much lighter, and the bill is shorter and narrower than in two males from Shanghai. Whether these differences are sexual or not it is impossible to say with the series at hand. The culmen measures 81; width of bill at base, 25.5 mm.

7. TADORNA TADORNA (Linnaeus)

Anas tadorna LINNAEUS, Sys. Nat., ed. 10, 1758, p. 122, (Sweden).

One female, 170 miles west-northwest of Paotow, Inner Mongolia, April 13.

8. CASARCA FERRUGINEA (Pallas)

Anas ferruginea PALLAS, Vroeg's Cat., Adumb., 1764, p. 5 (Tartary).

One male, Paotow, Inner Mongolia, March 22; 1 female, 10 miles northwest, March 27; 1 male, 92 miles northwest, April 2; and 2 males, 107 miles west-northwest of Paotow, Inner Mongolia, April 3–4; 1 male and 1 female, 45 miles northwest of Ninghsia, Kansu, May 10 and 22.

9. ANAS PLATYRHYNCHOS PLATYRHYNCHOS Linnaeus

Anas platyrhynchos LINNAEUS, Syst. Nat., ed. 10, 1758, p. 125 (Sweden).

One male, Eastern Tombs, Chihli, January 13.

10. ANAS POECILORHYNCHA ZONORHYNCHA Swinhoe

Anas zonorhyncha SWINHOE, Ibis, 1866, p. 394 (Ningpo).

One male, Ninghsia, June 3; two males and two females, 50 miles south-southwest of Ninghsia, Kansu, June 7.

I refer these specimens to the eastern race with some hesitancy. They are much lighter in color, especially below, but they seem nearer to it than they do to the race occurring in Yunnan and western Szechwan (*A. p. haringtoni*). From the latter they differ in being also lighter, especially below, and lack entirely or almost so, the paler edges to the feathers of the mantle. When a larger and better prepared series is available, it may be necessary to separate the bird occurring in the arid desert country from that from the coast.

11. DAFILA ACUTA ACUTA (Linnaeus)

Anas acuta LINNAEUS, Sys. Nat., ed. 10, 1758, p. 126 (Sweden).

One male, 92 miles north of Paotow, Inner Mongolia, April 2.

12. MERGUS MERGANSER MERGANSER Linnaeus

Mergus merganser LINNAEUS, Sys. Nat., ed. 10, 1758, p. 129 (Sweden).

One female, 45 miles northwest of Ninghsia, Kansu, May 7.

Family ACCIPITRIDAE

OLD WORLD VULTURES, HAWKS, OSPREYS, ETC.

13. AEGYPIUS MONACHUS (Linnaeus)

Vultur monachus LINNAEUS, Sys. Nat., ed. 12, vol. 1, 1766, p. 122 (Arabia).

Two flat skins killed by Mongols during the winter, 1922–23, in Alashan, 50–200 miles northwest of Ninghsia, Kansu.

One of the specimens (304559) has a white secondary covert in the right wing and a partially white one in the left, making the wings almost symmetrical in this respect.

14. GYPS HIMALAYENSIS Hume

Gyps himalayensis HUME, My Scrap Book, 1869, pp. 12, 15 (Himalayas, from Cabool to Bhootan).

One female, 20 miles west of Ninghsia, Kansu, June 2.

15. ACCIPITER NISUS NISOSIMILIS (Tickell)

Falco nisosimilis TICKELL, Journ. As. Soc. Bengal, vol. 2, 1833 or 34, p. 571 (Borabhum, India).

One female, 45 miles northwest of Ninghsia, Kansu, May 4.

This seems to be lighter above than specimens from central and south China that I have been calling *A. n. melanoschistus* Hume.

16. GYPAETUS BARBATUS GRANDIS Storr

Gypaetus grandis STORR, Alpenreise vom Jahre 1781 (1784), p. 69 (Switzerland).

Two adult flat native skins from the Kansu-Alashan border.

These are, judging from descriptions, fully adult. There are no European specimens in the same stage of plumage in the National

Museum. The striking thing about them is the heaviness of the fluffy under down to the upper parts; this is not noticeable in a made-up skin.

17. MILVUS LINEATUS (Gray)

Haliaetus lineatus GRAY, Hardwicke's Ill. Ind. Zool., vol. 1, 1832, p. 1, pl. 18 (China).

One male, 107 miles west-northwest of Paotow, Inner Mongolia, April 14; one female, southeast corner of Lake Kokonor, Tibet, August 14; one male, 30 miles west of Sining, Kansu, August 16.

18. PANDION HALIAETUS HALIAETUS (Linnaeus)

Falco haliaetus LINNAEUS, Sys. Nat., ed. 10, 1758, p. 91 (Sweden).

One female, 157 miles west-northwest of Paotow, Inner Mongolia, April 11.

This specimen has a wing 525 mm.

Family FALCONIDAE

FALCONS AND CARACARAS

19. FALCO REGULUS INSIGNIS (Clark)

Aesalon regulus insignis CLARK, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 470 (Fusan, Corea).

One male, Eastern Tombs, Chihli, December 19.

A specimen (296193) from the Likiang Plain, Yunnan, April 14, is much darker both above and below and probably belongs to another form, but what name it should bear is a question for the future.

20. CERCHNEIS TINNUNCULUS DÖRRIESI Swann

Cerchneis tinnunculus dörriesi SWANN, Syn. List. Accip., 1920, p. 146 (Sidemi, east Siberia).

Five males and one female, 45 miles northwest of Ninghsia, Kansu, May 3.

Both the males and female are considerably lighter than specimens from Szechwan and Yunnan (*C. t. saturatus*); the differences in size are not so great, but the northern birds average larger.

The two latest reviewers[3] of the kestrels of eastern Asia place the present race in the synonymy of *Cerchneis tinnunculus tinnunculus*, but the few specimens examined by me point to the birds from the dry arid region of the northeastern section being somewhat lighter than European specimens. Clark[4] named a pale form from Fusan,

[3] Rothschild, Nov. Zool., vol. 33, 1926, pp. 231–233; and Stuart Baker, Fauna Brit. India, Birds, ed. 2, vol. 5, 1928, pp. 60–67.

[4] Proc. U. S. Nat. Mus., vol. 32, 1907, p. 470.

Chosen, *Cerchneis perpallida*, and it may eventually prove to be the proper name to use for the present form, if recognizable. The type has a lighter gray head and a grayish bloom to the back not seen in the series of males from Ninghsia, Kansu; it is much lighter below. The form was founded on the single specimen, which may be aberrant or it may represent a recognizable form with a more eastern distribution than *C. t. dörriesi*. For the present I prefer to adopt a name of certain application.

21. CERCHNEIS TINNUNCULUS SATURATUS (Blyth)

Falco saturatus BLYTH, Journ. Asiat. Soc. Bengal, vol. 28, 1859, p. 277 (Tenasserim).

One immature male, Choni, Kansu, no date.

This belongs to the dark southern form.

Family PHASIANIDAE

PHEASANTS, ETC.

22. ALECTORIS GRAECA PUBESCENS (Swinhoe)

Caccabis chukar var. *pubescens* SWINHOE, Proc. Zool. Soc. London, 1871, p. 400 (Chefoo).

One female, Paotow, March 18; one male and one female, 30 miles northwest of Paotow, Inner Mongolia, March 29.

23. PERDIX BARBATA BARBATA Verreaux and Des Murs

Perdix barbata VERREAUX and DES MURS, Proc. Zool. Soc. London, 1863, p. 62, pl. 9 (Nertschinsk, Dauria).

One female, 107 miles west-northwest of Paotow, Inner Mongolia, April 4; one male, 45 miles northwest of Ninghsia, Kansu, May 3.

These two specimens are paler, above and below, than any in a small series from north China; in fact they are even paler below than a male of *Perdix b. turcomana* from Gulera, Ferghana, U.S.N.M. No. 159722. The chestnut bars above are somewhat heavier, especially in the female, than in North China specimens.

24. PERDIX HODGSONIAE SIFANICA Przewalski

Perdix sifanica PRZEWALSKI, Mongol i Strana Tangut, vol. 2, 1876 p. 124 (Mts. of Kansu); Rowley's Orn. Misc., vol. 2, 1877, p. 423 (transl.).

Two females, Labrang, August 29–30; two females, 105 miles south-southwest of Lanchow, Kansu, September 2.

A female taken August 30 is a bird of the year, about half grown.

The three adult females, compared with a male from Rama La Pass, west Szechwan, have narrower, paler chestnut collars and the

dark bars on the mantle narrower than the latter; this difference may be sexual, however.

25. COTURNIX COTURNIX JAPONICA Temminck and Schlegel

Coturnix vulgaris japonica TEMMINOK AND SCHLEGEL, Fauna Japon., Aves, 1842, p. 103, pl. 61 (Japan).

One male and one female, Eastern Tombs, December 21–23.

26. CROSSOPTILON AURITUM (Pallas)

Phasianus auritus PALLAS, Zoogr. Rosso-Asiat., vol. 2, 1827, p. 86 (Interior of China).

One male and two females, 120 miles south of Lanchow, Kansu, July 27 and August 2.

One of the specimens marked as a female is probably a male, as it has a blunt spur on the tarsus. This being the case, the only difference between the sexes is the somewhat larger size and the presence of a blunt spur on the tarsus in the males.

27. PUCRASIA XANTHOSPILA XANTHOSPILA Gray

Pucrasia xanthospila GRAY, Proc. Zool. Soc. London, 1864, p. 259, pl. 20 (Mts. N. W. of Peking).

Two males and two females, Eastern Tombs, Chihli, January 7.

28. PHASIANUS COLCHICUS ALASCHANICUS Alphéraky and Bianchi

Phasianus alashanicus ALPHÉRAKY and BIANCHI, Ann. Mus. Zool. St. Petersburg, vol. 12, pt. 4, 1908, pp. 434, 452 (Alashan).

Two males, 157 miles west-northwest of Paotow, April 3; one male, 210 miles west of Paotow, Inner Mongolia, April 17.

These specimens have a complete white collar. They resemble specimens I have been identifying as *P. c. kiangsuensis* from Shensi, but have the mantle and flanks yellow ocher or lighter, instead of a fiery cinnamon rufous; the red margins to the scapulars much narrower.

29. PHASIANUS COLCHICUS STRAUCHI Przewalski

Phasianus colchicus strauchi PRZEWALSKI, Mongol i Strana Tangut, vol. 2, 1876, p. 119, pl. 17 (Mts. of Kansu); Rowley's Orn. Misc., vol. 2, pt. 10, 1877, p. 417 (transl.).

Eight males, 2 females, and 2 downy young, from 30 miles east-southeast to 140 miles south of Lanchow, July 16–September 16; 1 male, 25 miles northwest of Sining, August 8; 1 female, 10 miles southeast of Labrang, August 31; 2 males without labels, all from Kansu.

The United States National Museum has two poor males from the type locality (Sungpan) of *P. c. suehchanensis* Bianchi; they differ from the above Kansu series in having the morocco red chest band much less fully developed and are really intermediate between this form and *P. c. elegans.*

The present form resembles *P. c. elegans;* the principal difference is that the shining bronzy green of the chest of that form is crossed in *P. c. strauchi* by a band of shining bronzy morocco red. None of the males in the series has a very long tail.

The summer males have the mantle a lighter red and the tails much lighter and the bars narrower than in fall birds; in fact the tails in the fall are of an entirely different color, the middle feathers sort of a sanford's brown, between the black bars, fading to drab with a little trace of brown by summer.

The downy chicks were taken August 25.

30. SYRMATICUS REEVESII (Gray)

Phasianus reevesii GRAY, Griffith's Anim. Kingd., vol. 8, (Aves. 3), 1823, p. 25 (China).

Three males and four females, Eastern Tombs, Chihli, January and May.

31. CHRYSOLOPHUS PICTUS (Linnaeus)

Phasianus pictus LINNAEUS, Sys. Nat., ed. 10, 1758, p. 158 (China).

One native made male skin purchased in New Taochow, Kansu, supposed to have come from the Szechwan border.

Family RALLIDAE

RAILS, COOTS, ETC.

32. FULICA ATRA ATRA Linnaeus

Fulica atra LINNAEUS, Syst. Nat., ed. 10, 1758, p. 152 (Sweden).

One female, 45 miles northwest of; 1 male and 1 female, 15 miles south-southwest of; and 1 male, 25 miles south-southwest of Ninghsia, May 10, June 5, and 6; 1 male, 1 female, and 1 young not able to fly, Lanchow, June 24. These birds are pale and the frontal shield is much swollen.

Family GRUIDAE

CRANES

33. ANTHROPOIDES VIRGO (Linnaeus)

Ardea virgo LINNAEUS, Syst. Nat., ed. 10, 1758, p. 141. (In Oriente.)

One female, 30 miles west of Ninghsia, Kansu, June 1.

Family CHARADRIIDAE

PLOVERS

34. VANELLUS VANELLUS (Linnaeus)

Tringa vanellus LINNAEUS, Sys. Nat., ed. 10, 1758, p. 148 (Europa, Africa).

Two males and one female, 157 miles west-northwest of Paotow, Inner Mongolia, April 3–9; one female, 10 miles south of Ninghsia, Kansu, October 15.

35. CHARADRIUS DUBIUS CURONICUS Gmelin

Charadrius curonicus GMELIN, Sys. Nat., vol. 1, pt. 2, 1789, p. 692 (Curonia).

One male, 45 miles northwest of Ninghsia, May 5; one male, 65 miles north of Lanchow, Kansu, June 17.

36. IBIDORHYNCHA STRUTHERSII Vigors

Ibidorhyncha struthersii VIGORS, Proc. Zool. Soc. London, 1830, p. 174 (Himalayan Mountains).

One female, 120 miles south of Lanchow, August 3; one female, 25 miles northwest of Sining, August 8; and one male, Choni, Kansu, August 12.

Family SCOLOPACIDAE

SANDPIPERS AND SNIPE

37. TOTANUS TOTANUS EURHINUS Oberholser

Totanus totanus eurhinus OBERHOLSER, Proc. U. S. Nat. Mus., vol. 22, 1900, p. 207 (Lake Tsomoriri, Ladak).

Two males and two females, southeast corner of Lake Kokonor, Tibet, August 14, 16.

38. TRINGA OCHROPUS Linnaeus

Tringa ochropus LINNAEUS, Sys. Nat., ed. 10, 1758, p. 149 (Sweden).

Three males and one female, 45 miles northwest of Ninghsia, Kansu, May 7–9; one male, Eastern Tombs, Chihli, January 13.

39. ACTITIS HYPOLEUCOS (Linnaeus)

Tringa hypoleucos LINNAEUS, Sys. Nat., ed. 10, 1758, p. 149 (Sweden).

Two males, 45 miles northwest of Ninghsia, Kansu, May 6 and 22; one female, southeast corner of Lake Kokonor, Tibet, August 14.

Family LARIDAE

GULLS AND TERNS

40. LARUS ICHTHYAËTUS Pallas

Larus ichthyaetus PALLAS, Reise Russ. Reichs, vol. 2, 1773, p. 713 (Caspian Sea).

One male and one female, southeast corner of Lake Kokonor, August 14.

Both of these specimens are immature, molting into the first winter plumage.

41. LARUS RIDIBUNDUS SIBIRICUS Buturlin

Larus ridibundus sibiricus BUTURLIN, Mess. Orn., vol. 2, 1911, p. 66 (Kolyma Delta).

One adult male and one not quite fully adult female, 157 miles west-northwest of Paotow, Inner Mongolia, April 11.

42. LARUS BRUNNEICEPHALUS Jerdon

Larus brunneicephalus JERDON, Madras Journ. Lit. and Sci., vol. 12, 1840, p. 225 (India).

One immature female, southeast corner of Lake Kokonor, Tibet, August 14.

43. STERNA HIRUNDO TIBETANA Saunders

Sterna tibetana SAUNDERS, Proc. Zool. Soc. London, 1876, p. 649 (Tibet).

One male, 15 miles south-southwest of Ninghsia, Kansu, June 5; two males and three females, Lanchow, Kansu, June 24–25; one male, southeast corner of Lake Kokonor, Tibet, August 14.

Two males in the United States National Museum from Ladak, taken July 29 and September 11, are considerably darker on the upper surface than any in the above series, and the Kansu specimens may constitute another recognizable form from the arid interior country, or they may possibly belong to the form named by Doctor Sushkin, *Sterna hirundo minussensis*.[5]

44. CHLIDONIAS LEUCOPAREIA SWINHOEI (Mathews)

Hydrochelidon leucopareia swinhoei MATHEWS, Birds Austral., vol. 2, 1912, p. 320 (Foochow, China).

One male, 15 miles south-southwest of Ninghsia, Kansu, June 5.

The series at my command is inadequate to properly determine the form of the above specimen. It closely resembles in color two males in the United States National Museum from Mindanao taken in May, but has a slightly longer wing. The wing measures 230 mm.

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[5] List and distr. birds Russian Altai, 1925, p. 64.

Family PTEROCLIDAE

SAND-GROUSE

45. SYRRHAPTES PARADOXUS (Pallas)

Tetrao paradoxus PALLAS, Reise Russ. Reichs, vol. 2, 1773, p. 712, pl. F (southern Tartary Desert).

One male, 107 miles northwest of Paotow, Inner Mongolia, April 3.

Family COLUMBIDAE

PIGEONS AND DOVES

46. COLUMBA RUPESTRIS RUPESTRIS Pallas

Columba oenas δ rupestris PALLAS, Zoogr. Rosso-Asia., vol. 1, 1827, p. 560 (Dauria).

Three males, 225 miles west of Paotow, Inner Mongolia, April 19; 1 male and 1 female, 55 miles, northwest of Ninghsia, Kansu, May 1; 1 female, Eastern Tombs, Chihli, January 8.

The above series is slightly lighter above and below than a small series from western Szechwan.

47. COLUMBA LIVIA NEGLECTA Hume

Columba neglecta HUME, Lahore to Yarkand, 1873, p. 272 (Ladak).

One male, Paotow, Inner Mongolia, March 21.

The above specimen can not be distinguished from a series of this form from Kashmir.

The United States National Museum has a specimen (No. 237656) from the Tai-peishan district, 80 miles west-southwest of Sianfu, Shensi, taken by Arthur de C. Sowerby, April 3, that comes very close to *neglecta* from Kashmir, also. It only differs in being very slightly paler above and below.

In the collection there is a male from Paotow and two females from 157 to 225 miles west of Paotow that are very dark, especially above, that I am not listing separately. These are evidently domestic pigeons gone wild. One has all the primaries on one wing white, except one, while in the other wing three are white. The National Museum also contains a specimen of this dark variety from Japan (No. 132432). Doctor Rock took it in south Kansu.[6]

Now whether the specimen listed as *Columba livia neglecta* from Paotow and the specimen referred to from Shensi belong to the domestic variety also, or are an extension to the east of the Turkestan form, some one in the future will have to decide. Certainly there seems to be no previous record so far to the eastward.

[6] Bull. Mus. Comp. Zoöl., vol. 68, 1928, p. 320.

48. STREPTOPELIA DECAOCTO DECAOCTO (Frivaldszky)

Columba risoria Linnaeus var. *decaocto* Frivaldszky, A. M. Társaság Evkönyvei (ungarische Akademieschriften), 1834–1836, 3 kötet (3 Band), osztály (Teil) 3, 1838, pp. 183, 184, pl. 8 (Turkey).

Two males and 1 female, Paotow, Inner Mongolia, March 18; 1 male and 1 female, 45 miles northwest of Ninghsia, Kansu, May 4.

49. STREPTOPELIA ORIENTALIS ORIENTALIS Latham

Columba orientalis Latham, Ind. Orn., vol. 2 1790, p. 606 (China).

One male, 30 miles west of Ninghsia, June 1; one male, 120 miles south of Lanchow, Kansu, July 26.

Family CUCULIDAE

CUCKOOS

50. CUCULUS CANORUS TELEPHONUS Heine

Cuculus telephonus Heine, Journ. f. Orn. 1863, p. 352 (Japan).

One adult female, 60 miles south-southwest of Ninghsia, June 8; 1 adult female, Lanchow, July 4; and 1 immature male, and 1 adult female, 120 miles south of Lanchow, May 28 and August 4, all in Kansu.

The two adults from Ninghsia and Lanchow are rather pale with the bars below very narrow.

Family BUBONIDAE

EARED-OWLS

51. ASIO OTUS OTUS (Linnaeus)

Strix otus Linnaeus, Sys. Nat., ed. 10, 1758, p. 92 (Sweden).

One female, Eastern Tombs, Chihli, January 10.

This is a very light-colored bird with the buffy markings above and below much reduced.

52. BUBO BUBO SETSCHUANUS Reichenow

Bubo bubo setschuanus Reichenow, Orn. Monatsb., 1903, p. 86 (Setschuan).

One male, Labrang, Kansu, August 30; one purchased native skin about 30 miles west of Sining, Kansu, winter.

The male from Labrang agrees (allowing for sex) with a specimen from Yunnan that the late Dr. Peter Suschkin identified as of this form; if anything it is slightly darker. The purchased specimen is considerably lighter than that from Labrang, and it is very doubtful if they belong to the same form; it is also probable that it

may have been brought from further north, but to what form to assign it is difficult to say at this time.

53. STRIX ALUCO MA (Clark)

Syrnium ma CLARK, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 471 (Fusan, Korea).

One female, Eastern Tombs, January 10.

If *Strix aluco ma* is really only a synonym of *Strix nivicola* Blyth, as suggested by Hartert,[7] then my *Strix nivipetens* is a very distinct species, but I am now of the opinion that the latter equals *Strix nivicola.* Only an examination of Blyth's type can settle the matter. *Syrnium ma* is certainly only a race of *Strix aluco* while *Strix nivicola* belongs to a southern type with a different wing formula and the toes more extensively bare; the coloration much darker. Since the above was written, Mr. Outram Bangs has examined the National Museum specimens of *Strix nivicola* and reached practically the same conclusions (Bull. Mus. Comp. Zoöl., vol. 70, 1930, p. 197).

54. ATHENE NOCTUA BACTRIANA Hutton

Athene bactriana HUTTON, Journ. As. Soc. Bengal., vol. 16, 1847, p. 776 (Old Candahar, Afghanistan).

One male, 180 miles west-northwest of Paotow, Inner Mongolia, April 14; two females, 85 and 65 miles north of Lanchow, Kansu, June 16 and 17.

The male from Paotow is slightly lighter even than a specimen of this form from Transcaspia. The two Kansu specimens are much like the Transcaspian bird above but slightly darker below, as they are more worn. Two males of *A. n. plumipes* from the Provinces of Shansi and Shensi are considerably darker, especially on the upper parts.

Family MICROPODIDAE

SWIFTS

55. MICROPUS APUS PEKINENSIS (Swinhoe)

Cypselus pekinensis SWINHOE, Proc. Zool. Soc. London, 1870, p. 435 (Peking).

One female, Lanchow, Kansu, July 11.

This is considerably lighter than Chihli specimens, but plaster had been used in its preparation and this always lightens dark-colored birds.

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[7] Vögel paläark. Fauna, part 7, 1913, p. 1026.

Family UPUPIDAE

HOOPOES

56. UPUPA EPOPS SATURATA Lönnberg

Upupa epops saturata LÖNNBERG, Arkiv för Zool., vol. 5, no. 9, 1909, p. 29 (Kjachta, Mongolia).

Two males, 100 miles northwest of Ninghsia, April 25; one male 15 miles east-southeast of Lanchow, Kansu, July 11.

Family PICIDAE

WOODPECKERS, ETC.

57. PICUS CANUS ZIMMERMANNI Reichenow

Picus canus zimmermanni REICHENOW, Orn. Monatsb., 1903, p. 86 (Tsingtao, Shantung).

Five males and four females, Eastern Tombs, Chihli, December 21 to January 18.

One male (304612) has the long nape feathers tipped with black, showing a tendency toward *Picus canus guerini.*

58. PICUS CANUS GUERINI (Malherbe)

Chloropicos guerini MALHERBE, Rev. et Mag. Zool., 1849, p. 539 (China).

Five males and 16 females, Kansu (Lanchow, July 3, 4; 15 miles east-southeast of Lanchow, July 10; 80 miles south of Lanchow, September 16; 90 miles southeast of Lanchow, September 1; 120 miles south of Lanchow, July 25–August 14; 10 miles north–east of Sining, August 4; Choni, July 4–August 7).

This series is too much abraded and faded to be used for comparison with fresh specimens. In the summer examples the green has practically faded from the back and breast. The autumn birds in fresh plumage agree fairly well with Shanghai specimens.

59. DRYOBATES MAJOR CABANISI (Malherbe)

Picus cabanisi MALHERBE, Journ. für Orn., 1854, p. 172 (China).

Two males and eight females, Eastern Tombs, Chihli, December 8–28.

60. DRYOBATES MAJOR STRESEMANNI Rensch

Dryobates major stresemanni RENSCH, Abh. u. Ber. Mus. f. Tierk. u. Volkerk. Dresden, vol. 16, No 2, 1924, p. 38 (Tsalila, Szechwan).

One male and two females, 90–120 miles south of Lanchow, Kansu, July 26, August 6, and September 1.

One of the females is still in immature plumage and the other female and the male are molting, apparently from a darker to a lighter plumage below.

Adult birds from Yunnan, when laid out in series, average darker below with more heavily barred outer tail feathers than specimens from Chihli or eastern China although a few individual birds from northern or eastern China approach them. The width of the white bars on the outer tail feathers shows a tendency to an increase in northern birds, but it is not constant; in specimens from Yunnan the heavy black barring on the outer tail feathers is apparently uniform, judging by the series in the United States National Museum. The Kansu specimens are somewhat intermediate between northern and Yunnan skins, but probably on the whole nearer the latter in the barring of the outer tail feathers.

61. YUNGIPICUS SCINTILLICEPS SCINTILLICEPS (Swinhoe)

Picus scintilliceps SWINHOE, Ibis, 1863, p. 96 (Peking).

Two males and six females, Eastern Tombs, Chihli, December 9–January 5.

It seems to me that *Yungipicus scintilliceps* is not a form of *semicoronatus* or *mitchellii* (=*pygmaeus* of authors), but had better be kept distinct; it contains several valid forms.

62. JYNX TORQUILLA JAPONICA Bonaparte

Yunx japonica BONAPARTE, Consp. Gen. Av., vol. 1, 1850, p. 112 (Japan).

One male and four females, Kansu (45 miles northwest of Ninghsia, May 10; 15 miles east-southeast of, July 10; 100 miles south of, August 27; and 120 miles south of Lanchow, July 26).

Family ALAUDIDAE

LARKS

63. OTOCORIS ALPESTRIS BRANDTI Dresser

Otocorys brandti DRESSER, Birds Europe, vol. 4, 1874, pp. 397, 402, (Kirgisen-Steppe).

One male, 92 miles northwest of Paotow, Inner Mongolia, April 2; 1 male, 15 miles northwest (Holanshan Mountains), May 12; 1 male, 30 miles west, June 1, 1 male, 45 miles northwest, May 5, and 1 male, 105 miles north-northwest of Ninghsia, April 24; 1 male, 65 miles north, June 17, and 2 immature males and 2 immature females 90–100 miles southwest of Lanchow, Kansu, August 28–September 1.

The adults in the above series agree fairly well with two specimens from the Russian Altai, except the wing seems to be shorter.

64. OTOCORIS ALPESTRIS NIGRIFRONS Przewalski

Otocoris nigrifrons PRZEWALSKI, Mongol i Strana Tangut, vol. 2, 1876, p. 103 (Kansu, Kokonor, Zaidam, and northern Tibet; type locality restricted by Bangs and Peters[8] to grasslands about Lake Kokonor).

One immature female, 40 miles west of Sining, Kansu, August 15; one adult and two immature males, southeast corner of Lake Kokonor, Tibet, August 14.

The only adult in the above series has a longer culmen than any in the series identified as *O. a brandti* from further east, and has the back darker and the black band across the forehead somewhat broader.

One of the immatures from Lake Kokonor is still in the spotted plumage.

The adult measures: Wing 115; culmen, 15 mm.

65. ALAUDA ARVENSIS INTERMEDIA Swinhoe

Alauda intermedia SWINHOE, Proc. Zool. Soc. London, 1863, p. 89 (Shanghai).

One female, Paotow, Inner Mongolia, March 19.

66. CALANDRELLA MINOR KUKUNOORENSIS (Przewalski)

Alaudula kukunoorensis PRZEWALSKI, Mongol i Strana Tangut, vol. 2, 1876, p. 103 (Kukunor and Tsai-dam); Rowley's Orn. Miscel., vol. 2, 1877, p. 316 (transl.).

One female and one unsexed, 92 and 107 miles northwest of Paotow, Inner Mongolia, April 2 and 3; one female, 55 miles northwest of Ninghsia, Kansu, May 1.

The above specimens have considerably longer wings and heavier bills than birds from northeast China (*C. m. cheleensis*). They do not seem to be very different in color.

67. GALERIDA CRISTATA RETRUSA Bangs and Peters

Galerida cristata retrusa BANGS and PETERS, Bull. Mus. Comp. Zoöl., vol. 68, 1928, p. 370 (Kanchow plain, foot of the northern Kanchow Nanshan).

Two males, Paotow, March 19; 1 female, 10 miles northwest, March 27; 3 males, 157 miles west-northwest, April 10; and 2 males, 120 miles west of Paotow, Inner Mongolia, October 21.

These average larger and somewhat lighter than birds from eastern China (*G. c. leautungensis*). If these are correctly identified, they constitute a considerable extension eastwards of the known range of the form.

68. GALERIDA CRISTATA LEAUTUNGENSIS (Swinhoe)

Alauda leautungensis SWINHOE, Ibis, 1861, p. 256 (Talienwan, Prov. Liautung).

One male, Eastern Tombs, Chihli, December 12.

[8] Bull. Mus. Comp. Zoöl., vol. 68, 1928, p. 370.

69. MELANOCORYPHA MONGOLICA (Pallas)

Alauda mongolica PALLAS, Reise Prov. Russ. Reichs, vol. 3, 1776, p. 697 (between Onon and Argun).

One male, southeast corner of Lake Kokonor, Tibet, August 14.

70. MELANOCORYPHA MAXIMA Gould

Melanocorypha maxima GOULD, Birds of Asia, vol. 4, 1867, pl. 72 and text (supposed to be Afghanistan).

One male and one female, southeast corner of Lake Kokonor, Tibet, August 14.

The male is considerably larger than the female.

Family HIRUNDINIDAE

SWALLOWS

71. PTYONOPROGNE RUPESTRIS (Scopoli)

Hirundo rupestris SCOPOLI, Annus I Hist.-Nat., 1769, p. 167 (Tirol).

One female, 15 miles northwest of Ninghsia (Holanshan Mountains), Kansu, May 16.

The above specimen and a male and female from Yunnan are darker above than a series from south Europe and Kashmir; the latter do not seem to differ in color from the typical race.

72. HIRUNDO RUSTICA GUTTURALIS Scopoli

Hirundo gutturalis SCOPOLI, Del. Flor. and Faun. Insubr., vol. 2, 1786, p. 96 (Nova Guiana).

One male and one female, 45 miles northwest of Ninghsia, Kansu, May 3 and 22; one immature male, Peking, Chihli, August 3.

73. HIRUNDO DAURICA DAURICA Linnaeus

Hirundo daurica LINNAEUS, Mantissa Plantarum, 1771, p. 528 (Siberia).

One female, 45 miles northwest of Ninghsia, May 26; one male and one female, 15 miles east-southeast of Lanchow, Kansu, July 10.

Family CORVIDAE

CROWS AND JAYS

74. CORVUS CORAX TIBETANUS Hodgson

Corvus tibetanus HODGSON, Ann. Mag. Nat. Hist., ser. 2, vol. 3, 1849, p. 203 (Tibet).

One male, 100 miles south of Lanchow, Kansu, August 30.

This is an immature bird molting into adult plumage. It is full grown and measures: Wing, 442; tail, 280; culmen, 79; depth of bill at base, 31.5 mm.

75. CORVUS MACRORHYNCHOS HASSI Reichenow

Corvus hassi REICHENOW, Orn. Monatsber., 1907, p. 51 (Tsingtau).

Two males and two females, Eastern Tombs, Chihli, January 11 and 14.

76. CORVUS CORONE ORIENTALIS Eversmann

Corvus orientalis EVERSMANN, Add. Pallas Zoogr., fasc. 2, 1841, p. 7 (Buchtarma).

One male, 100 miles southwest of Lanchow, Kansu, August 31.

77. COLOEUS DAUURICUS DAUURICUS (Pallas)

Corvus dauuricus PALLAS, Reise Russ. Reichs, vol. 3, Anhang, 1776, p. 694 (near Lake Baikal).

One male, Paotow, Inner Mongolia, March 18.

78. COLOEUS FUSCICOLLIS (Vieillot)

Corvus fuscicollis VIEILLOT, Tabl. Enc. Méth., Orn., vol. 2, 1823, p. 880 (Lake Baical).

Corvus neglectus SCHLEGEL, Bijdr. Dierk. Amsterdam, Afl. 8, Corvus, 1859, p. 16 (Japan).

One male and one female, 45 miles northwest of Ninghsia, May 4.

79. PICA PICA SERICEA Gould

Pica sericea GOULD, Proc. Zool. Soc. London, 1845, p. 2 (Amoy, Fukien).

Three males and four females, Eastern Tombs, Chihli, December 24–31.

80. CYANOPICA CYANA INTERPOSITA Hartert

Cyanopica cyana interposita HARTERT, Nov. Zool., vol. 24, 1917, p. 493 (Tsinling Mountains).

One male and 2 females, Eastern Tombs, Chihli, December 15 and 27; 1 adult male, 2 adult females, and 2 immature females, 120 miles south of Lanchow, July 20–August 16; 1 immature male and 1 immature female, 90 miles south of Lanchow, September 1; 1 immature female, 10 miles northeast of Sining, Kansu, August 4.

The adult Kansu birds are smaller with smaller bills than those from Chihli and may not belong to the same form. It may be there are only two forms, a northern and a southern, but where to draw the line is the difficulty.

81. UROCISSA ERYTHRORHYNCHA BREVIVEXILLA Swinhoe

Urocissa brevivexilla SWINHOE, Proc. Zool. Soc. London, 1873, p. 688 (Western hills of Peking).

One male and two females, Eastern Tombs, Chihli, December 31.

All specimens of this jay examined by me from north China are a much lighter blue above than those from the Yangtze south. This agrees with La Touche's[9] experience, also.

82. GARRULUS GLANDARIUS PEKINGENSIS Reichenow

Garrulus bispecularis pekingensis REICHENOW, Journ. für Orn., 1905, p. 425, (Peking).

One male, 100 miles southwest of, August 31, and 1 male, 90 miles southwest of Lanchow, Kansu, September 1.

The specimen taken August 31 agrees fairly well with a male from 15 miles south of Sianfu, Shensi of this form. The September bird shows an approach toward *G. g. brandti*; the speculum at the base of the inner primaries and outer secondaries is white distally on the eighth and ninth primary and without bars, the bars appearing basally and normally on the other feathers.

83. PYRRHOCORAX PYRRHOCORAX BRACHYPUS (Swinhoe)

Fregilus graculus var. *brachypus* SWINHOE, Proc. Zool. Soc. London, 1871, p. 383 (Peking).

One male and 1 female, Paotow, Inner Mongolia, March 18; 2 males and 2 females, 15 miles northwest of Ninghsia (Holanshan Mountains), Kansu, May 13–15; 1 male, Lake Kokonor, Tibet, August 13.

This series averages smaller with smaller bills than birds from southwest Szechwan and northern Yunnan (*P. p. himalayanus*).

84. PSEUDOPODOCES HUMILIS SAXICOLA Stresemann

Pseudopodoces humilis saxicola STRESEMANN, Ornith. Monatsb., vol. 36, 1928, p. 82 (Lamasery Mantusse, district of Sining-fu, N. Kansu).

One female, southeast corner of Lake Kokonor, Tibet, August 14; 1 female, 40 miles west of Sining, August 18; 5 males, 100 miles southwest of Lanchow, Kansu, August 28 and 29.

This is one of the most interesting birds received by the National Museum in recent years, representing a quite distinct monotypic genus. It differs from *Podoces* Fischer (type *Podoces panderi* Fischer) in the proportionally shorter tail and outer primary; the scutellation on the acrotarsium obsolescent, instead of well-marked and obvious. From *Eupodoces* Zarudny and Loudon (type *Podoces biddulphi* Hume) *Pseudopodoces* differs in the proportionally shorter tail, bill, and outer primary; the barbs on the feathers of the mentum less prominent; the feathers of the crown not metallic or obviously elongated posteriorly; and there are other characters, but enough have been enumerated to show that it is quite distinct. All three genera seem to be well-founded and worthy of recognition.

[9] Handbook Birds Eastern China, pt. 1, 1925, p. 17.

Pseudopodoces humilis is a small bird with a superficial resemblance to a lark. It is much smaller than the members of the other two genera mentioned above.

There are no typical *P. humilis* available for comparison and *P. h. saxicola* is here recognized on geographic grounds, the series being practically topotypic.

Family PARIDAE

TITMICE

85. PARUS MAJOR ARTATUS Thayer and Bangs

Parus major artatus Thayer and Bangs, Bull. Mus. Comp. Zoöl., vol. 52, 1909, p. 140 (Ichang, Hupeh, China).

Two males and one female, Eastern Tombs, Chihli, December 12–20.

In one male the black on the inner web of the outer tail feather occupies about half the web; in the other it is much reduced.

Ornithologists owe a debt of gratitude to La Touche [10] for straightening out the forms of this species occurring in eastern China.

86. PARUS MAJOR TIBETANUS Hartert

Parus major tibetanus Hartert, Vögel paläark. Fauna, vol. 1, pt. 3, 1905, p. 346 (Chaksam, Tsongpo Valley, Tibet).

Two males and two females, 120 miles south of Lanchow, Kansu, August 8–11.

These are all young birds, too young for correct determination. The tail is about two-thirds grown; the outer feather with only a narrow black border basally on the inner web.

No adult specimens from the type locality (Tatsienlu, Szechwan) of *Parus major subtibetanus* Kleinschmidt and Weigold [11] are available for comparison, but quite a large series from farther east in the Province, mostly from the vicinity of Suifu, do not appear to differ materially from birds from the mountains of northwest Yunnan that Rothschild [12] has assigned to *tibetanus*.

87. PENTHESTES SONGARUS AFFINIS (Przewalski)

Poecile affinis Przewalski, Mongol i Strana Tangut, vol. 2, 1876, p. 52; Rowley's Ornith. Miscell., vol. 2, 1877, p. 188 (Alashan Mountains and Kansu).

Three males, 15 miles northwest of Ninghsia (Holanshan Mountains), Kansu, May 13–14.

Przewalski (in the translation in Rowley's Ornith. Miscell., cited above) says: "Not having preserved any specimens from Muni-ul

[10] Handb. Birds Eastern China, pt. 1, 1925, pp. 23–25.
[11] Abh. u. Ber. Mus. Dresden, vol. 15, 1922, p. 11.
[12] Nov. Zool., vol. 30, 1923, p. 263.

and the Hoang-ho Valley, we can not state with certainty whether the birds we shot there belonged to the present species or not."

Not having any specimens for comparison, I can not do better; the above specimens do not exactly agree with the description. They resemble *Penthestes cinctus*, the top of the head is darker, not black, however, but sepia; the back and flanks not darker but lighter, not so tawny. It is a question, though, what Przewalski called black; he says *coffee-black*, probably meaning dark brown.

88. PERIPARUS ATER PEKINENSIS (David)

Parus pekinensis DAVID, Ibis, 1870, p. 155 (Peking, China).

One male, Eastern Tombs, Chihli, January 1.

89. AEGITHALOS GLAUCOGULARIS VINACEUS (Verreaux)

Mecistura vinacea VERREAUX, Nouv. Arch. Mus. Paris, vol. 6, Bull., 1870, p. 39 (mts. of Chinese Tibet).

Two females, Eastern Tombs, Chihli, December 13 and 18; one male immature, 120 miles south of Lanchow, Kansu, August 3.

A few years ago I recorded [13] a pair of these birds from the Lashipa Plain, Yunnan. Recently Lord Rothschild [14] has questioned this identification. The specimens in question are in worn plumage but are considerably larger than *Aegithalos glaucogularis glaucogularis*, of which the United States National Museum possesses a good series. At the time I made the above identification I did not have specimens of *A. g. vinaceus* for comparison, but the two above specimens confirm my identification of the Yunnan birds. *Mecistura vinacea* has usually been placed as a race of *Aegithalos caudatus* by authors, but La Touche [15] has made it a race of *glaucogularis*, which seems to me more logical. The two races differ principally in size.

Family PARADOXORNITHIDAE

PARROT-BILLS

90. SUTHORA WEBBIANA FULVICAUDA Campbell

Suthora fulvicauda CAMPBELL, Ibis, 1892, p. 237 (Chemulpo, Corea).

One female, Eastern Tombs, Chihli, January 5.

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[13] Proc. U. S. Nat. Mus., vol. 70, art. 5, 1926, p. 50.
[14] Nov. Zool., vol. 33, no. 4, 1927, p. 396.
[15] Handbook Birds Eastern China, pt. 1, 1925, p. 32.

Family SITTIDAE

NUTHATCHES

91. SITTA EUROPAEA AMURENSIS Swinhoe

Sitta amurensis SWINHOE, Proc. Zool. Soc. London, 1871, p. 350 (Amoorland).

Male and female, Eastern Tombs, Chihli, December 28 and January 5.

92. SITTA VILLOSA Verreaux

Sitta villosa VERREAUX, Nouv. Arch. Mus. Paris, vol. 1, Bull., 1865, p. 78, pl. 5, fig. 1 (north of Peking).

Three males, Eastern Tombs, Chihli, December 16–January 1.

Family CERTHIIDAE

CREEPERS

93. TICHODROMA MURARIA (Linnaeus)

Certhia muraria LINNAEUS, Sys. Nat., ed. 12, vol. 1, 1766, p. 184 (S. Europe).

One male, Paotow, Inner Mongolia, March 22; 1 male 15 miles northwest of Ninghsia (Holanshan Mountains), May 16; 1 male, 15 miles east-southeast of Lanchow, July 12; and 1 female (marked male), 30 miles west of Sining, Kansu, August 17.

While the United States National Museum has been accumulating quite a series of this species from Asia, it still lacks satisfactory material from Europe. A pair of birds from Saxony are much lighter and have longer bills than any I have been able to examine from Asia. Four females from Kashmir are darker and have shorter bills than a female from Saxony. A fair series from the mountains of China show quite a little variation among themselves. While they seem to average a clearer, purer gray above than Kashmir specimens, yet there are birds in the series that are identical with the latter, or almost so, and in any future subdivision should be kept together.

Family TIMALIIDAE

TIMALINE-BIRDS

94. PTERORHINUS DAVIDI DAVIDI Swinhoe

Pterorhinus davidi SWINHOE, Ibis, 1869, p. 61 (Peking).

Three females, Eastern Tombs, Chihli, December 10 and 18.

95. PTERORHINUS DAVIDI CONCOLOR (Stresemann)

Ianthocincla davidi concolor STRESEMANN, Journ. für Orn., 1923, p. 365 (Sungpan, N. Szechwan).

Three males, 15 and 45 miles northwest of Ninghsia (Holanshan Mountains), May 13 and 14; four males, 90 and 120 miles south of Lanchow, Kansu, July 28, August 9, and September 1.

The United States National Museum has recently acquired a good series of poor skins from Sungpan, Szechwan, the type locality of the form. They seem to have shorter and straighter bills than the Kansu birds, but apparently do not differ in color. Chihli birds are darker than those from Kansu. Since the above was written, Stresemann has named a race from Lanhukou, Kansu, *Ianthocincla davidi funebris*,[16] and Bangs and Peters have described *Ianthocincla davidi experrecta* from the Richthofen range.[17]

96. TROCHALOPTERON ELLIOTII PRJEVALSKII Menzbier

Trochalopteron prjevalskii MENZBIER, Ibis, 1887, p. 300 (Kansu Mountains).

Three males and 3 females, 120 miles south of Lanchow, July 30–August 16; 1 young male not long from the nest, 10 miles further south, September 13, and 1 female, 20 miles further south, September 10; 1 male, 15 miles northwest of Sining, Kansu, August 8.

This is a desert mountain form of *Trochalopteron elliotii*, much lighter in color with little or no white edgings to the feathers of the throat or black terminal or subterminal bars on the mantle. A certain number of *T. e. elliotii* have the central rectrices gray, aniline yellow only on the outer webs at the base, while two specimens of *T. e. prjevalskii* in the above series have the central rectrices yellow, so this supposed character for separating the two races does not hold.

In some of the August specimens of *prjevalskii*, the foreheads and pileum have bleached out to a pale drab gray, almost white. While this also happens with the more southern form to some extent, it is not near so pronounced, which was to be expected.

97. IANTHOCINCLA MAXIMA (Verreaux)

Pterorhinus maximus VERREAUX, Nouv. Arch. Mus. Paris, vol. 6, Bull., 1870, p. 36, pl. 3, fig. 1 (Mts. of Chinese Tibet).

One male, 120 miles south of, August 14, and 1 male and 2 females, 140 miles south of Lanchow, September 10; 1 male, Choni, Kansu, August 22.

The United States National Museum contains a large series of this species from further south, mostly from northern Yunnan. The southern birds appear to be somewhat darker and have a longer wing than those from Kansu. The three Kansu males have a wing 136–143; four males from Yunnan, 143–150 mm.

Family TURDIDAE

THRUSHES

98. TURDUS NAUMANNI Temminck

Turdus naumanni TEMMINCK, Man. d'Orn., vol. 1, 1820, p. 170 ("Les parties orientales; se montre en Silésie et en Autriche; plus commun en Hongrie").

Six males and four females, Eastern Tombs, Chihli, December 9–25.

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[16] Orn. Monatsbr., 1927, p. 134. [17] Bull. Mus. Comp. Zoöl., vol. 68, 1928, p. 339.

99. TURDUS EUNOMUS Temminck

Turdus eunomus TEMMINCK, Pl. Col., liv. 87, 1831, pl. 514 (Japan).

Two males, 45 miles north-west of Ninghsia, Kansu, May 22 and 26.

Both specimens have little rusty in the wings. The specimen taken on the 26th has the tail pattern, the back, and rusty spots on the sides and flanks much like *naumanni*. It is probably a hybrid.

100. TURDUS RUFICOLLIS Pallas

Turdus ruficollis PALLAS, Reis. Russ. Reichs, vol. 3, 1776, p. 694 (Dauria).

One female, Paotow, Inner Mongolia, March 22; 2 males, 2 females, and 1 unsexed, 45 miles northwest of Ninghsia, Kansu, May 4–7.

One male and one female included in the above collected May 4 I take to be hybrids between *Turdus ruficollis* and *eunomus*. The one marked female is like *ruficollis*, but the red area of the throat and chest is replaced by fuscous black; chin pinkish buff; feathers of throat edged with pinkish buff; the chest feathers edged with pale smoke gray. The one marked male has the chin and throat pinkish buff with two blackish rictal stripes; the chest feathers mikado brown with large brownish black centers and fringed with pinkish buff.

Rothschild[18] reports hybrids between *Turdus eunomus* and *naumanni*. Where the ranges of these closely related species meet, crossing apparently is not uncommon.

101. TURDUS GOULDII (Verreaux)

Merula gouldii VERREAUX, Nouv. Arch. Mus. d'Hist. Nat., vol. 6, Bull., 1870, p. 34 (Chinese Tibet).

Four adult males, two adult females, and two immatures, 120 miles south of Lanchow, Kansu, July 26–August 15.

I can not see that this bird is only a form of *castaneus*. They are too distinct in coloration, and if the ranges are given correctly in the manuals do not meet at any point.

102. TURDUS OBSCURUS Gmelin

Turdus obscurus GMELIN, Sys. Nat., vol. 1, pt. 2, 1789, p. 816 (Lake Baikal).

One female, 45 miles northwest of Ninghsia, May 22.

103. OREOCINCLA AUREA AUREA (Holandre)

Turdus aureus HOLANDRE, Annuaire de la Moselle, 1825, p. 60 (Metz).

Two females, 45 miles northwest Ninghsia, Kansu, May 7 and 21.

[18] Nov. Zool., vol. 30, 1923, pp. 43, 255.

104. MONTICOLA SAXATILIS (Linnaeus)

Turdus saxatilis LINNAEUS, Sys. Nat., ed. 12, 1766, p. 294 ("Helvetiae, Austriae, Borussiae montibus").

One male, 30 miles northwest of Ninghsia, Kansu, May 27.

There is only one adult male from Europe (Italy) available for comparison. It is darker above and on the breast than the Kansu bird; there is little, if any, difference in size.

105. CHAIMARRORNIS LEUCOCEPHALA (Vigors)

Phoenicura leucocephala VIGORS, Proc. Zool. Soc. London, 1831, p. 35 (Himalaya).

A good series from Kansu (from 15 miles east-southeast to 140 miles south of Lanchow, July 12–September 3; 30 to 40 miles west of Sining, August 12–17).

In the series there are a number of young and immature; three young (taken August 17, 20, and September 3) have short, stumpy tails and could not have left the nest very long. Strange to say they are remarkably like the adult, except the breast is black and the abdomen only tinged with cinnamon-rufous and apparently lack the spotted plumage of other members of the family. The rufous breast is assumed at the first winter plumage.

106. RHYACORNIS FULIGINOSA FULIGINOSA (Vigors)

Phoenicura fuliginosa VIGORS, Proc. Zool. Soc. London, 1831, p. 35 (Himalaya).

Two males and one female, 120 miles south of Lanchow, Kansu, July 21–August 11.

These specimens are in worn plumage; they, along with a specimen from Tai-pai-shan District, Shensi, are duskier than a series from Yunnan. Two males from Fukien are much lighter and probably belong to *Rhyacornis fuliginosa tenuirostris*.[19]

107. PHOENICURUS OCHRURUS RUFIVENTRIS (Vieillot)

Oenanthe rufiventris VIEILLOT, Nouv. Dict. d'Hist. Nat., vol. 21, 1818, p. 431 (Bengal).

Four males and a young in the spotted plumage, Kansu (15 and 30 miles northwest of Ninghsia, Holanshan Mountains, May 12–17; Lanchow, July 6; and 100 miles southwest of Lanchow, August 30).

The male, taken August 30, is a bird of the year and is molting into the first winter plumage which is apparently going to be identical with that of the adult. The spotted young was taken July 6.

[19] *Chimarrornis fuliginosa tenuirostris* Stresemann, Journ. für Orn., 1923, p. 364 (Siuhang, Kwangtung).

108. PHOENICURUS AUROREUS AUROREUS (Pallas)

Motacilla aurorea PALLAS, Reise Russ. Reichs, vol. 3, 1776, p. 695 (Salenka, Lake Baikal).

A good series from Kansu (30 to 60 miles northwest of Ninghsia, April 30–May 27; 15 to 140 miles south of Lanchow, July 23–September 20).

109. PHOENICURUS HODGSONI (Moore)

Ruticilla hodgsoni MOORE, Proc. Zool. Soc. London, 1854, p. 26, pl. 58 (Nepal).

Three males, Kansu (15 miles east-southeast, July 12; 40 miles south, September 19; and 120 miles south of Lanchow, August 6)

110. PHOENICURUS SCHISTICEPS (Gray)

Ruticilla schisticeps GRAY, Cat. Mam. Bds. Nepal Coll. Hodgson, 1846, pp. 69, 153 (Nepal).

One adult and one young male in the spotted plumage, 100 and 140 miles south of Lanchow, Kansu, August 22 and 30.

Stresemann [20] has named *Phoenicurus schisticeps beicki* from Lanhukou, Kansu. Bangs and Peters [21] discredit the form. No specimens from Nepal are available for comparison, but three males from Mili, southwest Szechwan and one from northern Yunnan compared with a series of seven males from Sungpan, northern Szechwan and the single male Kansu specimen support their remarks. The wings in four males from southwest Szechwan and northern Yunnan, measure: 81.5–85 (83.9); while the wings in the seven Sungpan and one Kansu male measure 81.5–86.5 (84.2).

111. PHOENICURUS ALASCHANICA (Przewalski)

Ruticilla alaschanica PRZEWALSKI, Mongol i Strana Tangut, vol. 2, 1876, p. 40, pl. 9, fig. 2 (Alaschan); Rowley's Orn. Miscel., vol. 2, 1877, p. 175, pl. 14, fig. 2.

Four males and one female, 15 miles northwest of Ninghsia (Holanshan Mountains), Kansu, May 12–15.

112. CYANOSYLVIA SUECICA PALLIDOGULARIS (Sarudny)

Cyanecula suecica pallidogularis SARUDNY, Mat. z. Kennt. d. Fauna und Flora Russ. Reichs, Zool., vol. 3, 1897, pp. 171, 312 (Orenburg).

One male, 45 miles northwest of Ninghsia, Kansu, May 18.

This is paler than a male from the Altai that has been referred to *C. s. discessa*, but I agree with S. Baker [22] that the latter is not distinct enough to warrant recognition by name.

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[20] Ornith. Monatsb., 1927, p. 134.
[21] Bull. Mus. Comp. Zoöl., vol. 68, p. 352.
[22] Fauna Br. India, Birds, ed. 2, vol. 2, 1924, p. 85.

113. CALLIOPE CALLIOPE CALLIOPE (Pallas)

Motacilla calliope PALLAS, Reise Russ. Reichs, vol. 3, 1776, p. 697, (Jenisea usque ad Lenam).

Two males, 45 miles northwest of Ninghsia, Kansu, May 21 and 26.

These belong to the small western form; farther east in Kamchatka occurs a larger form that winters in the Philippines, *Calliope calliope camtschatkensis* (Gmelin).

114. HODGSONIUS PHOENICUROIDES ICHANGENSIS Baker

Hodgsonius phoenicuroides ichangensis BAKER, Bull. Br. Orn. Club, vol. 43, 1922, p. 18 (Ichang, Hupeh).

A young male in the spotted plumage with a short stubby tail, not long from the nest, 90 miles southwest of Lanchow, Kansu, September 1.

115. SAXICOLA TORQUATA PRZEWALSKII (Pleske)

Pratincola maura var. *przewalskii* PLESKE, Wiss. Res. Przewalsky's Reisen, Vögel, vol. 1, 1889, p. 46, pl. 4, figs. 1, 2, 3 (Kansu).

One female, 140 miles south of Lanchow, Kansu, September 11.

116. OENANTHE LEUCOMELA LEUCOMELA (Pallas)

Motacilla leucomela PALLAS Nov. Comm. Petr., vol. 14, 1771, p. 584, pl. 22 (Lower Volga).

One male, 15 miles northwest of Ninghsia (Holanshan Mountains), Kansu, May 12; one female, 157 miles northwest of Paotow, Inner Mongolia, April 3.

117. OENANTHE DESERTI ATROGULARIS (Blyth)

Saxicola atrogularis BLYTH, Journ. As. Soc. Bengal, 1847, p. 131 (Upper provinces, Scinde, etc.).

One male and two females, Inner Mongolia (70 miles northwest, March 31, and 157 miles west-northwest of Paotow, April 7 and 8); two males, Kansu (100 and 105 miles northwest of Ninghsia, April 24 and 25).

The male taken April 25 lacks the white rump and upper-tail coverts. Upon careful examination the latter seem to be entirely lacking; as some fresh new white feathers, concealed by the longer old ones, are coming in around the base of the tail, the character of the breeding plumage will probably be assumed later. The specimen does not differ from the other two males otherwise, except the tail is somewhat shorter.

118. OENANTHE ISABELLINA (Temminck)

Saxicola isabellina TEMMINCK, Pl. Col., livr. 79, 1829, pl. 472, fig. 1 (Nubia).

One young male not long from the nest, 45 miles northwest of Ninghsia, Kansu, May 22.

119. PRUNELLA FULVESCENS MONGOLICA Sushkin

Prunella fulvescens mongolica SUSHKIN, Proc. Boston Soc. Nat. Hist., vol. 38, No. 1, 1925, p. 52 (Kobdo, N. W. Mongolia).

One female, 157 miles west-northwest of Paotow, Inner Mongolia, April 8.

This may not be true *mongolica*. It is darker above than a female specimen from the Tian Shan Mountains, north of Kashgar, taken September 13 (*P. f. juldussica*).

120. PRUNELLA FULVESCENS NANSHANICA Sushkin

Prunella fulvescens nanshanica SUSHKIN, Proc. Boston Soc. Nat. Hist., vol. 38, No. 1, 1925, p. 51 (Kwei-Te-ting or Gui-dui).

Four males, 15 miles northwest of Ninghsia (Holanshan Mountains), Kansu, May 12.

This series is paler above and below than the specimen identified above as *P. f. mongolica*. It is quite possible that the above specimens do not belong to this form at all. They are much lighter, both above and below than *Prunella fulvescens nadiae* Bangs and Peters [23] from Choni, S. W. Kansu. The dark stripes on the back are narrower and lighter in color. They are in a more worn and bleached condition, but this will not account for some of the differences. The Holanshan chain seems to be more or less the eastern terminus of the Nanshan system. A desert or semidesert intervenes between the ranges of *nadiae* and the present form.

Family SYLVIIDAE

WARBLERS

121. SYLVIA CURRUCA AFFINIS Blyth

Sylvia affinis BLYTH, Journ. As. Soc. Bengal, vol. 14, 1845, p. 564 (India).

One male, 45 miles northwest of Ninghsia, Kansu, May 6.

122. RHOPOPHILUS PEKINENSIS (Swinhoe)

Drymoeca pekinensis SWINHOE, Ibis, 1868, p. 62 (Pekin).

One male, 120 miles west of Paotow, Inner Mongolia, October 22.

This is so very different from *Rhopophilus albosuperciliaris* (Hume) that it is difficult to believe they represent forms of a single species.

123. PHAEORHADINA FUSCATA FUSCATA (Blyth)

Phyllopneuste fuscata BLYTH, Journ. As. Soc. Bengal, vol. 11, 1842, p. 113 (Calcutta).

Two males, 45 miles northwest of Ninghsia, Kansu, May 19–20.

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[23] Bull. Mus. Comp. Zoöl., vol. 68, 1928, p. 355.

124. REGULOIDES PROREGULUS PROREGULUS (Pallas)

Motacilla proregulus PALLAS, Zoogr. Rosso-Asiat., vol. 1, 1811 (1827), p. 499 (Ingoda River, Dauria).

One male, 45 miles northwest of Ninghsia, Kansu, May 20.

Family MUSCICAPIDAE

FLYCATCHERS

125. SIPHIA PARVA ALBICILLA (Pallas)

Muscicapa albicilla PALLAS, Zoogr. Ross.-Asiat., vol. 1, 1827, p. 462 (Dauria).

Three males and one female, Kansu (45 miles northwest of Ninghsia, May 22–27; 100 miles south of Lanchow, September 15).

Family MOTACILLIDAE

WAG-TAILS AND PIPITS

126. MOTACILLA ALBA OCULARIS Swinhoe

Motacilla ocularis SWINHOE, Ibis, 1860, p. 55 (Amoy, China).

One male, 45 miles northwest of Ninghsia, Kansu, May 8.

127. MOTACILLA ALBA LEUCOPSIS Gould

Motacilla leucopsis GOULD, Proc. Zool. Soc. London, 1837, p. 78 (India).

One female, 45 miles northwest of Ninghsia, May 4; two males and one female 15 miles northwest of Ninghsia (Holanshan Mountains), May 12–13; one female and one male, 120 miles south of Lanchow, July 21 and September 6; one female, 100 miles southwest of Lanchow, (10 miles southeast of Labrang), August 31; one male, 20 miles west of Sining, Kansu, August 18.

This seems to be the resident breeding form.

128. MOTACILLA ALBA BAICALENSIS Swinhoe

Motacilla baicalensis SWINHOE, Proc. Zool. Soc. London, 1871, p. 363 (Eastern Asia).

One male, 70 miles northwest, March 31, and one male and one female, 157 miles north-northwest of Paotow, Inner Mongolia, April 3 and 9.

This form is larger, has the jugular black patch larger, and less white on the wing coverts than *M. a. leucopsis*. The present form has the back gray in the breeding plumage, while in *M. a. leucopsis* it is black. In winter the two forms are much alike, however, and rather difficult to separate.

129. MOTACILLA CINEREA CASPICA (S. G. Gmelin)

Parus caspicus S. G. Gmelin, Reise durch Russland, vol. 3, 1774, p. 104, pl. 20, fig. 2 (Engeli, Caspian Sea).

Two males and one female, 45 miles northwest of Ninghsia, May 7–26.

130. BUDYTES THUNBERGI, subspecies?

Motacilla thunbergi Billberg, Syn. Fauna Scand., vol. 1, pt. 2, Aves, 1828, p. 50 (Lapland).

One male, Lanchow, Kansu, June 24.

The above specimen is brighter yellow below, less greenish above, and lacks the dusky streaks on the jugulum of *B. t. plexus*. It probably belongs to the form left unnamed by Doctor Sushkin,[24] but I do not care to name it from a single specimen and the material at hand at present.

It seems to me *Budytes thunbergi* is specifically distinct from *Budytes flavus*, and that *Budytes flavus plexus* Thayer and Bangs and *Budytes flavus alascensis* Ridgway are really forms of *thunbergi;* such an arrangement would certainly show their relationship better.

131. BUDYTES CITREOLA CITREOLA (Pallas)

Motacilla citreola Pallas, Reise Prov. Russ. Reichs, vol. 3, 1776, p. 606 (Eastern Siberia).

Four males and one female, 45 miles northwest of Ninghsia, Kansu, May 7–27.

132. ANTHUS SPINOLETTA BLAKISTONI Swinhoe

Anthus blakistoni Swinhoe, Proc. Zool. Soc. London, 1863, p. 90 (Yangtze River, 150 miles inland).

One male, 100 miles south of Lanchow, Kansu, September 15.

133. ANTHUS ROSEATUS Blyth

Anthus roseatus Blyth, Journ. Asiat. Soc. Bengal, vol. 16, 1847, p. 437 (Nepal).

Two males, 60 and 15 miles northwest of Ninghsia, Kansu, April 30 and May 15.

The specimen taken April 30 is very deeply colored. The foreneck and chest vinaceous-buff; the outer margins of the primaries and upper parts with a warbler green wash. These tints seem to fade rather rapidly.

134. ANTHUS HODGSONI BEREZOWSKII Zarudny

Anthus maculatus berezowskii Zarudny, Orn. Monatsb., vol. 18, 1909, p. 41 (S. W. Kansu).

Two females, 45 miles northwest of Ninghsia, Kansu, May 8–22. These two skins are very light colored with the back sparsely

[24] Proc. Boston Soc. Nat. Hist., vol. 38, no. 1, 1925, p. 37.

streaked. Birds from the high mountains of Yunnan are more heavily streaked on the upper parts; this form has been named *Anthus maculatus yunnanensis* by Uchida and Kuroda.[25] Dr. C. W. Richmond[26] renamed *Anthus maculatus* Hodgson, *nomen nudum*, *Pipastes maculatus* Jerdon, not *Motacilla maculata* Gmelin, *Anthus hodgsoni*. This would make the type locality of the latter Nepal and probably Uchida and Kuroda's form is a synonym of it. The only safe course for the present is to use a name of undoubted applicability.

135. ANTHUS RICHARDI RICHARDI Vieillot

Anthus richardi VIEILLOT, Nouv. Dict. d'Hist. Nat., vol. 26, 1818, p. 491 (France).

Four males and one unsexed, 45 miles northwest of Ninghsia, May 7–19; one male, 30 miles east-southeast of Lanchow, July 16; one female, 100 miles southwest of Lanchow, Kansu, August 31.

The August specimen is a bird of the year with some immature plumage on the back. I have no specimens of *A. r. striolatus* for comparison and most of my *richardi* are birds taken on migration. In size they seem to agree with specimens from east China.

Family BOMBYCILLIDAE

WAXWINGS

136. BOMBYCILLA GARRULA CENTRALASIAE Poljakow

Bombycilla garrulus centralasiae POLJAKOW, Messr. Orn., vol. 6, 1915, p. 137 (Zaissan Dist., Altai).

A large series, Eastern Tombs, Chihli, November 16–January 3.

The above series when compared with a small number of European specimens is much lighter and grayer, both above and below, but especially above.

Family LANIIDAE

SHRIKES

137. LANIUS SPHENOCERCUS SPHENOCERCUS Cabanis

Lanius sphenocercus CABANIS, Journ. für Orn., 1873, p. 76 (Canton).

One female, 25 miles south-southwest of Ninghsia, June 6; one male, 15 miles south of Ninghsia, Kansu, October 14.

138. LANIUS TEPHRONOTUS Vigors

Lanius tephronotus VIGORS, Proc. Zool. Soc. London, 1831, p. 43 (Himalaya).

One male, 15 miles northwest of Ninghsia, May 16; 5 males, 15 miles east-southeast of Lanchow, July 10–11; 3 males, 1 female,

[25] Annot. Zool. Jap., vol. 9, 1916, 134.
[26] Research in China, Carnegie Inst., vol. 1, pt. 2, 1907, p. 493.

and 2 immature males, 120 miles south of Lanchow, July 22–August 15; 1 immature female, 10 miles northeast of Sining, Kansu, August 4.

These have been compared with a large series from northern Yunnan. They are lighter above, the black mask on the forehead is not so broad, the rusty of the rump is not so extensive, and there are other slight differences. They appear also to be somewhat smaller.

This is considerably north of the range given by Hartert.[27]

139. LANIUS CRISTATUS ISABELLINUS Hemprich and Ehrenberg

Lanius isabellinus HEMPRICH and EHRENBERG, Symb. Phys., 1828 (1833), fol. e. (Gumfuda, Arabia).

Two males and 2 immature females, 30–45 miles west of Ninghsia; 1 immature female, 120 miles south of Lanchow, Kansu, July 22.

The immature from Lanchow is too young for correct determination; it is rather dark and may not belong here at all.

Family STURNIDAE

STARLINGS

140. SPODIOPSAR CINERACEUS (Temminck)

Sturnus cineraceus TEMMINCK, Pl. Col., liv. 94, 1835, pl. 556 (Japan).

Five males and 4 females, Lanchow, Kansu, June 24–September 21.

141. AGROPSAR STURNINUS (Pallas)

Gracula sturnina PALLAS, Reise Russ. Reichs, vol. 3, 1776, p. 695 (south Dauria).

Four males and one female, Lanchow, Kansu, June 26 and July 7.

Family FRINGILLIDAE

SPARROWS

142. CHLORIS SINICA SINICA (Linnaeus)

Fringilla sinica LINNAEUS, Sys. Nat., ed. 12, vol. 1, 1766, p. 321 (China).

Ten males from Kansu (Lanchow, July 4; 15 and 30 miles east-southeast of Lanchow, July 10 and 14; 120 miles (July 26–August 10) and 180 miles south of Lanchow, September 1).

While the above series is very satisfactory, there is no comparable material available from south China taken at the same season. A series taken mostly in fall and winter with a few summer birds

[27] Vögel paläark. Fauna, vol. 1, pt. 4, 1907, 451.

from southern Szechwan average a little smaller; the differences are slight and grade into one another. The few summer specimens that I have seen from the south appear to be more richly colored than the Kansu birds.

The measurements given by Jacobi [28] for his *Chloris sinica tschiliensis* are no greater than those of this Kansu series and only average slightly greater than the series from south China. Of *Chloris sinica ussuriensis* Hartert, I have examined only two adult males and one female; they are slightly larger than Kansu birds, but the difference is not great.

143. MYCEROBAS CARNIPES (Hodgson)

Cocothraustes carnipes Hodgson, Asiatic Researches, vol. 19, 1836, p. 151 (Nepal).

One male and one female, 15 miles northwest of Ninghsia (Holan-shan Mountains), Kansu, May 16.

Four males from southwest Szechwan and northern Yunnan are a deeper black when compared with the above male; the Kansu female is a lighter gray than females from Yunnan and southwest Szechwan. Perhaps the northern bird represents another form, but for the present I do not care to separate it.

144. FRINGILLA MONTIFRINGILLA Linnaeus

Fringilla montifringilla Linnaeus, Sys. Nat., ed. 10, 1758, p. 179 (Europa, *i. e.* Sweden).

Two females, Eastern Tombs, Chihli, December 8 and January 4.

145. SPINUS SPINUS (Linnaeus)

Fringilla spinus Linnaeus, Sys. Nat., ed. 10, 1758, p. 181 (Sweden).

One female, Eastern Tombs, Chihli, December 10.

The above specimen has a deformed bill; the lower mandible much longer than the upper.

146. ACANTHIS FLAVIROSTRIS MINIAKENSIS Jacobi

Acanthis flavirostris miniakensis Jacobi, Abh. und Ber. Mus. Dresden, vol. 16, No. 1, 1923, p. 25 (Tschuwo, Bameh; Dawo).

One marked male but probably a female, 105 miles south-southwest of Lanchow, Kansu, September 2.

This specimen has been assigned to this form on geographic ground. It is immature; an adult female in worn plumage from Ngan Yang Ba (near Tatsienlu), July 19, is much darker above and below and more heavily streaked.

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[28] Abh. u. Ber. Zool. Mus. Dresden, vol. 16, No. 1, 1923, p. 25.

147. PYRGILAUDA RUFICOLLIS (Blanford)

Montifringilla ruficollis BLANFORD, Proc. Asiat, Soc. Bengal, 1871, p. 227 (Kangra Lama Pass, north Sikkim).

One male, 40 miles west of Sining, Kansu, August 15.

This bird has quite a remarkable bill. The base of the upper mandible is swollen around the nostrils, which are exposed and open upward; between the nostrils the culmen is raised for a short distance basally into a sort of knob or short ridge.

148. RHODOSPIZA OBSOLETA (Lichtenstein)

Fringilla obsoleta LICHTENSTEIN, in Eversmann's Reise, Anhang, 1823, p. 132 (Buchara).

Two females, 70 miles northwest of Paotow, Inner Mongolia, March 31.

A small series (four males and one female) from east Turkestan, taken in August and November, are browner above and lighter below than the above specimens. This difference is probably seasonal, as the August bird still retains some of the browner summer plumage below.

149. ERYTHROSPIZA MONGOLICA (Swinhoe)

Carpodacus mongolicus SWINHOE, Proc. Zool. Soc., 1870, p. 447 (Nankow Pass).

Two males, Paotow, Inner Mongolia, March 18; 1 male and 2 females, 70 miles northwest of Ninghsia April 29, and 1 immature female Lanchow, Kansu, July 9.

A small series in the United States National Museum from Kashmir (1 male and 1 female) and east Turkestan (Tian Shan Mountains, north of Kashgar, 2 males and 3 females), taken in November and September, are less suffused with pinkish below and on the wings and seem to lack the whitish mark on the outer web of the inner secondaries that is such a prominent feature in the above series. Whether these differences are seasonal or not I am not prepared to say.

150. PASSER MONTANUS OBSCURATUS Jacobi

Passer montanus obscuratus JACOBI, Abh. und Ber. Mus. Dresden, vol. 16, No. 1, 1923, p. 32 (Prov. Hupeh and Szetschwan).

Four males and two females, Paotow, Inner Mongolia, March 20; two females, 30 miles northwest of Paotow, March 29.

This series does not seem to differ from Hupeh and Szechwan birds. One of the females taken, March 29, is a partial albino.

151. PASSER AMMODENDRI STOLICZKAE Hume

Passer stoliczkae HUME, Stray Feathers, vol. 2, 1874, p. 516, (Yarkand, Kaschgar).

One male, 60 miles northwest of Ninghsia, Kansu, April 30.

152. CARPODACUS ERYTHRINUS ROSEATUS (Hodgson)

Pyrrhulinota roseata HODGSON, Proc. Zool. Soc. London, 1845, p. 36 (Nepal).

One male and 1 female, 15 miles south of Ninghsia (Holanshan Mountains), May 16 and 18; 5 males and 1 female, 120 miles south of Lanchow, Kansu, July 20–August 10.

153. CARPODACUS ROSEUS (Pallas)

Fringilla rosea PALLAS, Reise Prov. d. Russ. Reichs, vol. 3, 1776, p. 69 (Udam et Selengam).

Seven males (adults and immature), Eastern Tombs, December 11–January 8.

154. CARPODACUS THURA DUBIUS Przewalski

Carpodacus dubius PRZEWALSKI, Mongol i Strana Tangut, vol. 2, 1876, p. 92, pl. 13 (Alashan Mountains and Kansu); Rowley's Orn. Miscell., vol. 2, 1877, p. 301, pl. 53.

One male, 15 miles northwest of Ninghsia (Holanshan Mountains), May 15; two males, 140 miles south of Lanchow, Kansu, August 24 and September 11.

The two latter specimens have the colors of the lower parts intensified; the September specimen being Corinthian red, even deeper on sides of neck. This deepening of color is probably due to wear.

155. CARPODACUS ARGYROPHRYS Berlioz

Carpodacus argyrophrys BERLIOZ, Bull. Mus. Paris, ser. 2, vol. 1, No. 2, February, 1929, p. 131 (new name for *Carpodacus davidianus* authors not Milne-Edwards).

Five males, 15 miles northwest of Ninghsia (Holanshan Mountains), May 12–18; one male, 55 miles northwest of Ninghsia, Kansu, May 1.

This series of six males measures: Wing, 76, 78.5, 79, 79, 80, 80; culmen, 11–11.5. *Carpodacus pulcherrimus* and *C. argyrophrys* are extremely hard to differentiate and have been confused by most authors. Rothschild [29] called attention to certain differences and recognized them as forms of the same species. Bangs and Peters,[30] the latest authors to deal with these birds, recognize the two as distinct species, because they find them occuring together in parts of their range. They give characters separating the two birds, in which size is mentioned first. Now taking the series of males in the United States National Museum of *pulcherrimus* and *argyrophrys* and separating them on this character, using the Kansu series above as a criterion, we get the following result: 3, Sungpan, Szechwan, July 22–24, wing, 81–84; 2, near Tatsienlu, Szechwan, July 14–18, wings

[29] Nov. Zool., vol. 33, 1926, p. 330.
[30] Bull. Comp. Zoöl., vol. 68, 1928, p. 374.

of both, 84; 1, Likiang Mountains, Yunnan, April 17, wing, 86. All the above are assigned to *Carpodacus argyrophrys*. To *Carpodacus pulcherrimus* are assigned the following: 5 Sungpan, Szechwan, July 13–August 2, wing, 70.5–77; 3, near Tatsienlu, Szechwan, July 13–August 3, wing, 74–75; 1 male, Cheto, Szechwan, July 25, wing, 72.5. Besides the greater size of *C. argyrophrys*, the series separated above on size as of this species differs from those assigned to *C. pulcherrimus* in being more silvery pink, not so reddish below, especially on the throat and superciliary and the upper parts somewhat lighter. All the specimens assigned to *C. pulcherrimus* above have the wing not over 75, except one that goes to 77. This one is assigned here on color. The specimens assigned to *C. argyrophrys* have a wing length of 76 (one) to 86; the bills also seem to be longer and heavier. If it were not for the fact that these two birds occur together over parts of their range in the breeding season, they would certainly only be regarded as closely related forms of a single species.

156. LOXIA CURVIROSTRA ALBIVENTRIS Swinhoe

Loxia albiventris SWINHOE, Proc. Zool. Soc. London, 1870, p. 437 (Peking).

One male and one female, Eastern Tombs, Chihli, December 27–28.

157. PYRRHULA ERYTHACA TAIPAISHANENSIS Rothschild

Pyrrhula erythaca taipaishanensis ROTHSCHILD, Nov. Zool., vol. 28, 1921, p. 63 (Mt. Tai-pai-shan, Tsin-ling Mts.).

One male and one female, 120 miles south of Lanchow, Kansu, July 26, and August 13.

I have previously commented on the difference between the present race and *Pyrrhula erithaca wilderi*.[31]

While the female of the present form is considerably lighter than the same sex of *Pyrrhula erithaca altera* from Yunnan, the male is remarkably similar, only differing in size, being slightly smaller.

158. EMBERIZA SCHOENICLUS PALLIDIOR Hartert

Emberiza schoeniclus pallidior HARTERT, Vögel paläark. Fauna, vol. 1, pt. 2, 1904, p. 197 (Aiderli, Turkestan).

One male, 10 miles northwest of Paotow, Inner Mongolia, March 27.

This is in a lightly streaked, light colored, winter plumage. I am not sure it belongs to this form as there are no specimens at hand in the same stage of plumage for comparison. In the pattern of the tail it agrees with the species and I am placing it here on geographic grounds.

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[31] Proc. U. S. Nat. Mus., vol. 70, art. 5, 1926, p. 58.

159. EMBERIZA PALLASI PALLASI (Cabanis)

Cynchramus pallasi CABANIS, Mus. Hein., vol. 1, 1851, p. 130 (based on *Emberiza schoeniclus* B. PALLAS, Zoogr.; Transhaikalia, Selenga River).

Four males, 157 miles west-northwest of Paotow, Inner Mongolia, April 10 and 11; one male, Eastern Tombs, Chihli, January 4.

Doctor Sushkin [32] has recently divided this species into three races, but the material at my command will not permit me to go into the matter. Three of the Paotow males have broad white nuchal bands; much more so than a breeding male from the Kolyma in worn plumage; the white mark on the second outer tail feather in the latter is much smaller also, and it is very doubtful if they belong to the same form.

160. EMBERIZA RUSTICA Pallas

Emberiza rustica PALLAS, Reise Russ. Reichs, vol. 3, 1776, p. 698 ("In salicetis Dauuriae").

One male and two females, Eastern Tombs, Chihli, December 12–January 1.

161. EMBERIZA ELEGANS TICEHURSTI Sushkin

Emberiza elegans ticehursti SUSHKIN, Bull. Brit. Orn. Club, vol. 47, 1926, p. 35 (new name for *Emberiza elegans sibirica* Sushkin not *Emberiza sibirica* Gmelin; Sidemi).

One male, Eastern Tombs, Chihli, December 17.

162. EMBERIZA GODLEWSKII BANGSI Sushkin

Emberiza godlewskii bangsi SUSHKIN, Proc. Boston Soc. Nat. Hist., vol. 38, No. 1, 1925, p. 27 (Pashui, Shansi, China).

Six males from Kansu: 15 miles northwest of Ninghsia (Holanshan Mountains), May 12–17; 45 miles northwest of Ninghsia, May 5; 30 miles east-southeast of Lanchow, July 16.

This is a larger and lighter-colored form than *Emberiza godlewskii omissa.* A male in the United States National Museum (No. 150326) from Tangitar, east Turkestan, June 12, is even lighter and has the white on the two outer tail feathers more extensive than the Kansu bird, and evidently represents *Emberiza g. decolorata* Sushkin. It is slightly larger, but this might not hold in a series. The Kansu specimens are probably not typical of the race, but intergrades toward *Emberiza g. nanshanica.*

163. EMBERIZA GODLEWSKII NANSHANICA Sushkin

Emberiza godlewskii nanshanica SUSHKIN, Proc. Boston Soc. Nat. Hist., vol 38, No. 1, 1825, p. 24 (Churmyk River, Tibet).

Four males and two females, Kansu (120 miles south of Lanchow, July 24–August 12; and 100 miles southwest of Lanchow, August 31).

[32] Proc. Boston Soc. Nat. Hist., vol. 38, No. 1, 1925, pp. 20–22.

Two of the males (304993, 304990) are as large as the same sex in the series of *Emberiza g. bangsi* from Kansu, but are much darker in color and are probably only unusually large specimens. The characters of the two forms seem to run into one another and must intergrade somewhere in the vicinity.

164. EMBERIZA GODLEWSKII OMISSA Rothschild

Emberiza cia omissa ROTHSCHILD, Nov. Zool., vol. 28, 1921, p. 60 (Si Taipaishan, Tsin-ling Mountains).

One male, Eastern Tombs, Chihli, January 2.

This specimen is smaller and darker than the specimens identified as *E. g. bangsi.*

165. EMBERIZA CIOIDES WEIGOLDI Jacobi

Emberiza cioides weigoldi JACOBI, Abh. und Ber. Mus. Dresden, vol. 16, No. 1, 1923, p. 36 (Peking, Chihli).

Two males and one female, Eastern Tombs, Chihli, December 18, January 4; one female, 30 miles northwest of Paotow, Inner Mongolia, March 29.

The latter specimen is lighter below than the Chihli birds.

Although the United States National Museum contains quite a series of this species from China, it has very few taken in the breeding season. What few I have been able to examine from south and north China seem to show that the present form is very poorly characterized, if worthy of recognition at all. I have been able to compare three males in breeding plumage from north Chihli with four males from south China (Kiangsu, Hunan, and Szechwan). Southern birds appear to be a trifle darker and a little smaller; the differences are slight, however.

166. EMBERIZA LEUCOCEPHALA S. G. Gmelin

Emberiza leucocephalos S. G. GMELIN, Nov. Comm. Acad. Sci. Imp. Petrop., vol. 15, 1771, p. 480, pl. 23, fig. 3 (Astrachan).

One male and one female, Eastern Tombs, Chihli, December 8 and 24.

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ON DINOSAURIAN REPTILES FROM THE TWO MEDICINE FORMATION OF MONTANA

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INTRODUCTION

The Blackfeet Indian Reservation in northern Montana has been the object of two expeditions by the Smithsonian Institution. It was here in deposits of the Two Medicine (Upper Cretaceous) formation that, in 1913, I discovered the type specimen of *Brachyceratops montanensis*.[1] The collections of this first expedition were so promising that it was deemed highly desirable that the region should be visited a second time. This desire was realized in 1928, and the specimens described in the following pages are a part of this latter collection, which, as a whole, adds considerably to our knowledge of this meagerly known fauna and places it on a basis where comprehensive comparisons with Upper Cretaceous faunas of adjacent regions are now possible.

The bulk of the collection will be described in a later paper, but I have thought it advisable to record as soon as possible the discovery of three genera new to the fauna, which include two new species.

1. A NEW SPECIES OF PALAEOSCINCUS

Among vertebrate fossils collected from the Two Medicine formation (Upper Cretaceous) of Montana, by a Smithsonian paleontological expedition in 1928, is a disarticulated skeleton of an armored dinosaur displaying characters which indicate it to be an undescribed species of the long established but little known genus *Palaeoscincus*.

Palaeoscincus costatus,[2] founded by Dr. Joseph Leidy in 1856 on a single tooth (pl. 4, fig. 3) was the first named North American armored dinosaur. For more than half a century this remained a genus of doubtful affinities, but with the acquisition by the American

1 Gilmore, C. W., Prof. Paper 103, U. S. Geol. Surv., 1917.
2 Proc. Phila. Acad. Sciences, vol. 8, 1856, p. 72.

Museum of Natural History of an unusually well preserved anterior portion of a skeleton (pl. 8) with the armor in place, a real conception of the extraordinary characteristics of this animal was first disclosed. A few teeth found in the cavities of the skull are said by Matthew [3] to be identical in character with the type of *Palaeoscincus costatus* thus establishing its identity.

Reference of the present specimen to the genus *Palaeoscincus* is based on similarity of dermal armor and skull resemblances to the American Museum specimen. Although much of the anterior portion of that skeleton is present, it has not yet been described, and for comparative purposes one must rely almost entirely upon the excellent illustrations published by Matthew.

The specimen from the Two Medicine formation, considered here, contributes so much to our knowledge of the skeletal anatomy of the animal that it is described in considerable detail. The teeth, however, although having the general cut of the *Palaeoscincus costatus* tooth, differ sufficiently in their details to indicate a distinct species.

The new genus and species *Edmontonia longiceps* recently described by C. M. Sternberg,[4] displays such striking likeness in its skull structure to the *Palaeoscincus* cranium now before me as to raise a question as to the validity of this new genus. In the arrangement and number of skull plates, and structure of the palate, the two skulls are almost identical, differing pricipally in proportions. The teeth also are not greatly unlike the typical *Palaeoscincus* tooth. At this time I am not fully satisfied that there are good generic distinctions for separating these two genera but shall withhold final judgment until other parts of the *Edmontonia* type have been studied.

The occurrence of *Edmontonia* in the geologically higher Edmonton formation, may lend some weight to the possiblity of its generic distinctness, for few dinosaurian genera are known to pass over from one formation to another.

PALAEOSCINCUS RUGOSIDENS, new species

Plates 1, 2, 3, 4, Figure 1; Plates 5, 6, and 7

Type.—No. 11868, U.S.N.M., consists of a complete skull; right ramus; coössified atlas and axis; the third and two other cervical vertebrae; ten dorsal and eleven caudal vertebrae; sacrum; two ischia; portion of right ilium; right pubis; seventeen ribs half of which are complete; chevrons; numerous parts of bones; and fifty dermal ossifications of various kinds. The specimen was found by George F. Sternberg, June 3, 1928.

[3] Natural History, vol. 22, No. 4, 1922, p. 334.
[4] Trans. Roy. Soc. Canada, vol. 22, 1928, pp. 93–106.

Type locality.—Sec. 16, T. 37 N., R. 8 W., Milk River, Blackfeet Indian Reservation, Glacier County, Montana.

Horizon.—Two Medicine formation, Upper Cretaceous.

The specimen on which the present description is based was found on the north side of Milk River about one-half mile west and south from the locality where the type of *Brachyceratops montanensis*[5] was discovered by the writer in 1914. All the bones were disarticulated and widely scattered, but it was quite apparent they pertained to a single individual as there was no duplication of parts.

Skull.—The skull, aside from slight flattening due to postmortem crushing, is in an almost perfect state of preservation. Normally depressed, it diminishes in both height and breadth toward the muzzle, which is squarely truncate. Widest immediately posterior to the orbits, the breadth abruptly contracts behind the eyes, forming a distinct notch on either side as contrasted with those of much lesser degree in both *Panoplosaurus mirus* and *Edmontonia longiceps*. The orbits are of moderate size and set far back. The narial openings are large and open outward and upward. The lateral temporal fenestra look outward and slightly backward.

The whole of the exposed skull surface, top, front, and sides, is covered by a few ossified dermal plates. These are coössified with the underlying skull bones, concealing them from view. The plates are defined by shallow circumscribing sulci, which in this specimen can not be traced out in their entirety, as is shown in Plate 2.

In so far as the number, form, and proportions of these head plates can be determined, they most nearly resemble those of *Edmontonia longiceps*. The observed difference in form and proportions between the plates of *Palaeoscincus rugosidens* and those of *E. longiceps* and *Panoplosaurus mirus*, in all probability are of but little anatomical significance, for in dermal bones there seems to be considerable variation among individuals of the same species.

Viewed from the side the superior outline of the skull is moderately convex from front to back and likewise from side to side. Behind the line of the orbits on either side of the midline are large shallow depressions as in the cranium of *E. longiceps*. The withdrawal inward of the dentigerous border of the maxillary, brings about a depressed buccal area of considerable extent, well illustrated in Figure 2. Dermal ossifications cover the entire side of the skull, thus obliterating all sutures between the individual bones.

In the posterior view (fig. 1) the skull bones are free from dermal covering and although the individual elements can be determined, all of the sutures are coalesced thus rendering it impossible to determine their precise limits.

[5] Gilmore, C. W., Prof. Paper, 103, U. S. Geol. Surv., 1917.

The occipital condyle is relatively large and directed obliquely downward in relation to the longer axis of the skull, indicating the normal pose of the head to form an obtuse angle with the neck. The condyle is subspherical, the greatest diameter being transverse. It has a greatest width of 58 mm., and a greatest vertical diameter of 52.5 mm.

The exoccipitals extend outward and backward, their outer ends projecting backward beyond the occipital condyle. The outer or paraoccipital processes form the two small horn-like projections shown in the superior view of the skull (pl. 2). These bones are indistinguishably fused with the exoccipitals.

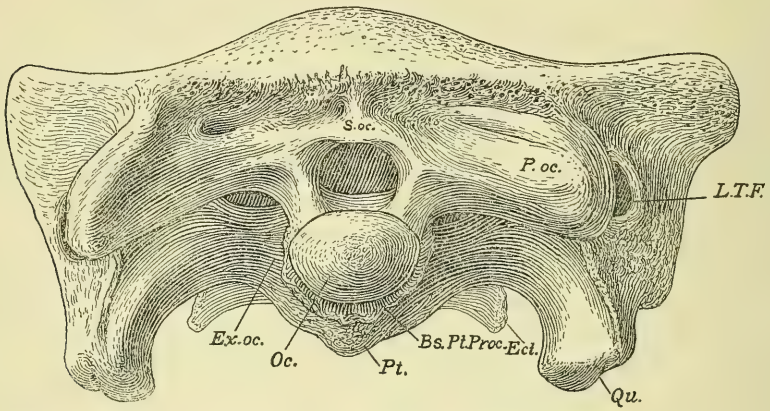

FIGURE 1.—SKULL OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. POSTERIOR VIEW. ONE-THIRD NATURAL SIZE. *Bs. pt. Proc.*, BASIPTERYGOID PROCESS, OF THE BASISPHENOID; *Etc.*, ECTOPTERYGOID; *Ex. oc.*, EXOCCIPITAL *L. T. F.*, LATERAL TEMPORAL FENESTRA; *Oc.*, OCCIPITAL CONDYLE; *P. oc.*, PARAOCCIPITAL PROCESS; *Pt.*, PTERYGOIDS; *Qu.*, QUADRATE; *S. oc.*, SUPRAOCCIPITAL

The supraoccipital strongly overhangs the foramen magnum. The latter is suboval in outline, and has a greatest transverse diameter of 33 mm. and a vertical diameter of 28 mm.

The quadrates are wide transversely, and of moderate thickness. A wide process that projects forward and inward is firmly coalesced with the pterygoids. The upper end is fully enveloped by the overlying squamosal and posteriorly these ends are coalesced with the paraoccipitals. Viewed from below the distal articular end of the quadrate is triangular in outline (fig. 2). The main articular face for the ramus has its greatest diameter fore and aft. Toward the outside it slopes upward. From an external view only the thin edge of the quadrate is seen and it is covered by a roughtened dermal growth of bone.

The palate side of the skull is in an excellent state of preservation. Slight crushing and loss of a few minor pieces is all that mars

its perfection. Unfortunately most of the sutures are obliterated, making it quite impossible to determine the extent of many of the elements. Except for differences in proportion, the palate structures seems to be identical with *Edmontonia longiceps* as described by Sternberg.[6]

The outstanding peculiarities of structure observed in the palate of this specimen are the ladle-shaped form of the premaxillary region; the division of the mouth longitudinally by a vertical plate of bone that extends backward from the median junction of the premaxillaries; the great shortening of the pterygoids, the inward curvature of the tooth rows, and the wide overhanging buccal area along the outer sides of the maxillary bones.

The edentulous premaxillary bones form the greater part of the large rectangular muzzle. As mentioned above, their combined inner surfaces are hollowed out, in form suggesting a ladle. The outer anterior borders curve strongly downward, forming a sharp cutting edge that in life was doubtless covered by a chitinous sheath. On either side external to this sharp ridge of bone the premaxillaries are widened by dermal bones that are firmly coössified to it. A low, subacute median ridge rising on the anterior third extends backward to the junction with the prevomers. On either side of the midline the premaxillaries are pierced by small rounded foramina that lead upward and forward through the floor of the anterior nares. The sutures between premaxillaries, maxillaries, and prevomers are clearly determinable as shown in Figure 2. On the right side the border of the premaxillary shows deformation in the form of a notch, evidently due to an injury received in life, since the edges of the bone had healed as indicated by their rounded borders.

The maxillae have the greater portion of their outer surfaces hidden by the covering of dermal bone. Anteriorly they meet the premaxillae, internally the prevomers, and toward the posterior end the ectopterygoids. The striking characteristic of these bones is the curved nature of the dentigerous border. The teeth are borne on a downwardly descending plate that gradually recedes in height toward the front. The tooth rows are wide apart posteriorly (144 mm.), but curve in rapidly to a point forward of their mid-length where they become parallel. In front the teeth of opposite sides are only 77 mm. apart, exactly half the space of the posterior ones. There are sixteen alveoli in each maxillary bone, and these occupy a space of 120 mm. measured in a straight line. Judging from the relative sizes of the alveoli, the teeth decrease in size from back to front.

[6] Trans. Roy. Soc. Canada, vol. 22, 1928, pp. 98–100, pl. 2.

The spear-shaped bone filling the interspace between the maxillae is here regarded as the combined prevomers. The pointed end is interposed between the coalesced premaxillae, while the hinder ends

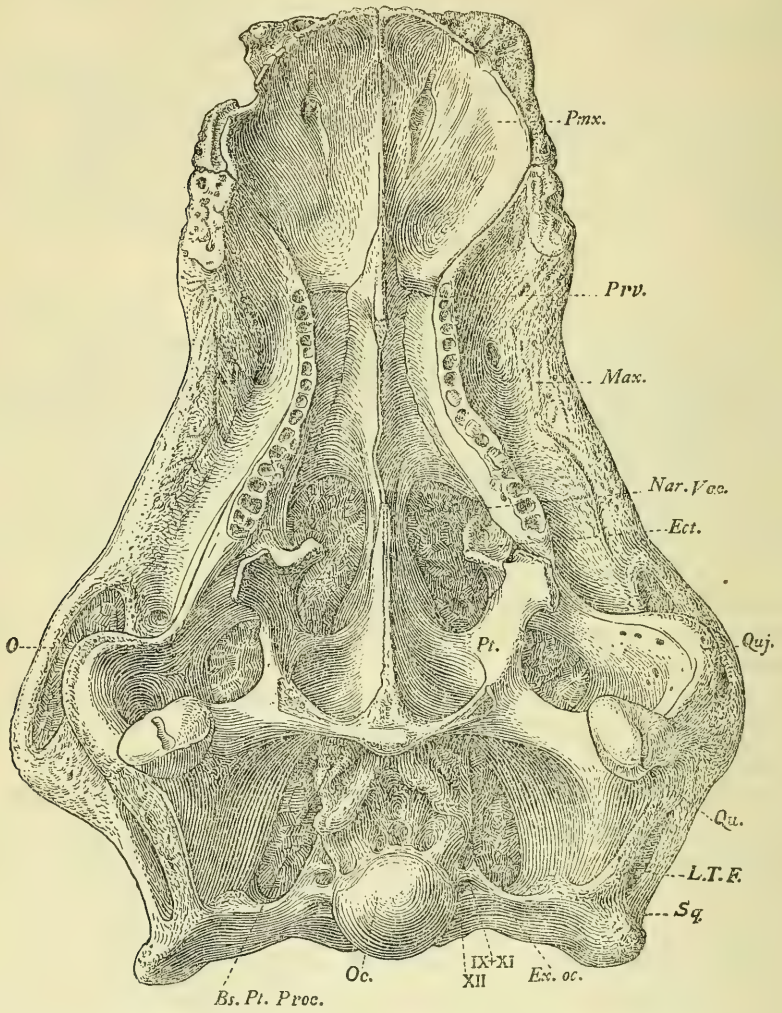

FIGURE 2.—SKULL OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. INTERIOR VIEW. ONE-THIRD NATURAL SIZE. *Bs. Pt. Proc.*, BASIPTERYGOID PROCESSES; *Ect.*, ECTOPTERYGOID; *Ex oc.*, EXOCCIPITAL; *L. T. F.*, LATERAL TEMPORAL FENESTRA; *Max.*, MAXILLARY; *Nar. Vac.*, NARIAL VACUITY; *O*, ORBIT; *Oc.*, OCCIPITAL CONDYLE; *Pmx.*, PREMAXILLARY; *Prv.*, PREVOMER; *Pt.*, PTERYGOIDS; *Qu.*, QUADRATE; *Quj.*, QUADRATOJUGAL; *Sq.*, SQUAMOSAL; *IX, XI, XII*, EXITS FOR CRANIAL NERVES

form the anterior borders of the internal nares, and on the midline articulate with the palatines. Sternberg was certainly mistaken in regarding this portion of the palate in *Edmontonia longiceps* as

being a posterior extension of the premaxillae. The most striking feature of these bones is the development of a vertical plate that extends downward and divides the mouth longitudinally. This plate anteriorly extends below the level of the tooth rows. In the specimen under consideration the greater part of this plate is missing, but is completely preserved in the type of *Edmontonia longiceps* and has been described in detail by Sternberg,[7] who says: "This plate seems to be a development of the fused premaxillae." In this, however, I think he is mistaken; for in specimen No. 11868 this ridged plate certainly develops on the prevomers as shown in Figure 2. The purpose of this longitudinal plate is as yet unexplained, but that it had a function there can be no doubt. A suggested similarity is found in the palate of *Troödon validus*, but in that genus it consists only of a pointed pendant[8] process.

The palatines as distinct bones can not be differentiated in this skull. It is presumed, however, that they form the median bar of bone which separates the internal nares. That they probably form the posterior boundary of the nares is indicated in the type of *Edmontonia longiceps*, where Sternberg was able to trace out a part of the palatine-pterygoid suture. In the present skull all trace of this suture has been obliterated. If correct in the determination of these bones, the palatines form a considerable portion of the vertical plate which divides the mouth cavity. Anteriorly they join the prevomers, apparently intercalated between slender posteriorly directed processes of those bones.

The pterygoid bones, as in nearly all of the armored Dinosauria, are greatly shortened antero-posteriorly. Each element may be said to consist of three plates of bone, a rather narrow wing that extends backward and outward and joins the quadrate, further in front a nearly vertical lamina that extends forward to articulate with the ectopterygoids, and at the junction of the two processes mentioned above a heavier vertical plate extends transversely to meet its counterpart of the opposite side on the median line. At their junction the bone swells out into a truncated triangular process that projects downward considerably below the rest of the bone. A median septa continues forward and upward from this process to meet the palatines. On either side of this septa the pterygoids are hollowed out. The sutural contact with the ectopterygoids seem to be as indicated in Figure 2, but I have some misgivings as to whether they are fractures or true sutures.

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[7] Trans. Roy. Soc. Canada, Art. 3, Vol. 22, 1928, pp. 99–100.
[8] Gilmore, C. W., Univ. of Alberta, Bull. No. 1, 1924, pl. 5.

Table of comparative measurements

	Type of *Palaeoscincus rugosidens*	Type of *Edmontonia longiceps*	Type of *Panoplosaurus mirus*
	Mm.	*Mm.*	*Mm.*
Greatest length of skull, in straight line	470	490	355
Greatest breadth just back of orbits	340	290	294
Breadth of beak, anterior end	145	110	121
Greatest breadth of beak	187	150	----
Breadth of paroccipital processes	240	210	----
Length of quadrate	[1] 150	118	----
Distance between distal ends of quadrates	185	165	----
Greatest length of orbit	64	70	66
Vertical diameter of orbit	----	50	47
Greatest diameter of foramen magnum	40	32	58
Transverse diameter of occipital condyle	57	50	58

[1] Estimated.

Lower jaw.—The right ramus is preserved almost in its entirety as shown in Figure 3. Its outstanding peculiarities of structure are the great depth of the posterior third; the brevity of the postcoronoidal portion; the curved dental row; and the short, inwardly curved symphysial end. It probably includes all of the elements common to the ramus of the predentate dinosauria but in this specimen most of the sutures are fully fused so that the separate elements of the jaw can not be differentiated.

Much of the outer and lower surface of the ramus, except at the posterior end, is covered by a thick dermal bone which effectually conceals most of the underlying elements. The keeled nature of this dermal bone is well shown in Plate 3. The dermal plate is everywhere fully fused to the underlying bones. The armor does not cover the posterior end of the ramus and here the posterior mandibular elements can be seen. The angular-surangular suture remains distinct from the posterior border to the point where it passes beneath the overlying armor. It shows the angular to have a greatest posterior depth of 42 millimeters, but this rapidly diminishes as the bone passes forward. All of the sutures of the internal side of the ramus are obliterated through fusion. The dentary, which constitutes fully two-thirds of the entire ramus, is roughly rectangular with a much narrowed portion that turns strongly inward to form the symphysis. The alveolar border shows sockets for 21 teeth, the same as in *Euoplocephalus tutus*, but three more than in the ramus of *Edmontonia longiceps*. These occupy a space 140 millimeters in extent, indicating the teeth to be slightly smaller than in *E. longiceps* where 18 teeth occupy a space 155 millimeters in length. The tooth row forms a sinuous curve that con-

forms to the curved maxillary row (fig. 3B). Posterior to the last alveolus the superior border curves gently upward as a pointed process that is enveloped by the coronoid which appears to be astride it. On the internal side the splenial completely covers Meckel's groove. On this side a horizontal ridge is developed which becomes more prominent anteriorly where it finally forms the posterior boundary of the symphysial part of the dentary. Here the main body of the bone changes from a vertical to a horizontal position. The union of the dentary with the posterior elements can not be determined.

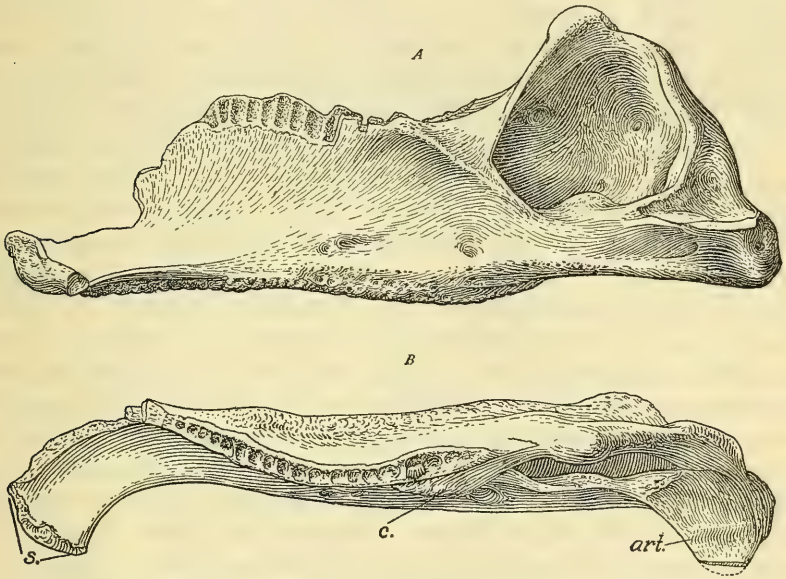

FIGURE 3.—RIGHT RAMUS OF PALEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. *A*, INNER VIEW; *B*, SUPERIOR VIEW. BOTH ONE-THIRD NATURAL SIZE. *Art.*, ARTICULAR; *C.*, CORONOID; *S.*, SYMPHYSICAL BORDER

The coronoid sends forward an anterior portion that laps along the supero-posterior portion of the dentary as shown in Figure 3. It forms much of the anterior border of the mandibular fossa, which is extensive. A second process is sent forward on the outside of the dentary but its full extent can not be determined. Posteriorly, however, it is so fully fused that its limits can not be recognized.

The articular is prominently developed extending inward as a shelf-like platform that, viewed from above, is subtriangular in shape. The cotylus is shallowly concave antero-posteriorly, being divided into two parts by a low, rounded, longtiudinal ridge. The prearticular is probably present but is thoroughly coössified.

Measurements of ramus

	Mm.
Greatest length of ramus	360
Greatest depth through coronoid	121
Greatest depth of dentary at center	87
Greatest depth of dentary at symphysis	17
Length of dentigerous border	140

Teeth.—Four teeth are preserved, three in the left maxillary and one in the right dentary. The tooth illustrated (fig. 4) is the fifth enumerated from the posterior end of the maxillary, while the germ tooth shown in Figure 5 is the twelfth of this same series. These teeth are retained in their respective alveoli in such a manner that only their internal surfaces are visible and for that reason can not be completely compared with the teeth of other described forms. The functional tooth consists of a laterally compressed crown and evidently a long cylindrical root. The crown is swollen at the base with a roughened cingulum as shown in Figure 4. It is to this roughening of the lower part of the crown that the specific name *rugosidens* refers. The anterior and posterior margins of the crown are denticulate, there being three denticles posterior and four anterior to the apical denticle, making eight in all. The three central denticles, which in this tooth are missing, appear to have been united as they are in the typical *Palaeoscincus costatus* tooth (fig. 3, pl. 4). The other denticles are sharp pointed and continue down the inner face of the crown as low, well-defined ridges. The germ tooth has seven denticles, all displaying distinct points, as shown in Figure 5. The apical denticle is slightly posterior to the central vertical line. The anterior teeth, judging from the relative sizes of the alveoli, are smaller than the posterior.

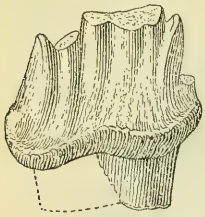

FIGURE 4.—MAXILLARY TOOTH OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. INTERNAL VIEW. TWO AND ONE-HALF TIMES NATURAL SIZE

FIGURE 5.—CROWN OF GERM MAXILLARY TOOTH OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. INTERNAL VIEW. TWO AND ONE-HALF TIMES NATURAL SIZE

In relative size, the one functional tooth present agrees almost precisely with the type tooth of *Palaeoscincus costatus*. They also agree in having a similar number of denticles with the median ones closely united. On the other hand their successive arrangement differs, and whereas *P. rugosidens* has the lower part of the crown ornamented with a rugose crinkling of the surface, the crown surface in *P. costatus* is always smooth.

In the paleontological collections of the United States National Museum there are between 50 and 60 teeth from the Judith River beds of Montana, that with a few exceptions are of similar pattern

and can be identified as *P. costatus*. None of these, however, shows sculpturing of the crown surface. From this brief review it is quite apparent that the teeth are near enough alike to indicate congeneric relationships, but are sufficiently unlike, in the light of our present knowledge, to show them to pertain to distinct species.

Three other species of this genus have been proposed at various times, *Palaeoscincus asper* Lambe,[9] *P. latus* Marsh,[10] and *P. magoder* Hennig.[11] The last is said by Hay [12] to be a *nomen nudum* and may, therefore, be dismissed from further consideration. The type of *P. latus*, from the Lance formation, is a stegosauroid style of tooth that can at once be distinguished from the teeth of *P. rugosidens* by its low crown and the regularity of its denticles. (See pl. 4, fig. 4.) *P. asper* may likewise be distinguished by the more numerous denticles, sides of crown more conspicuously ridged, and a double row of denticles at one end of the cutting edge. (See pl. 4, fig. 2.)

Atlas and axis.—The atlas and axis are fused together by their centra, nueral arches, and spines, a condition previously observed by Sternberg [13] in *Panoplosaurus mirus*. The English *Scelidosaurus* [14] likewise has a fusion of the atlas and axis. In *Stegosaurus* these bones remain distinct.

The cup on the anterior extremity of the atlas for the reception of the occipital condyle is deep and subcircular in shape. It has a depth of 31 millimeters and a greatest estimated transverse diameter of 57 millimeters. The atlas is long, broad, relatively low and without ventral keel. It bears strong, coösified, single-headed cervical ribs that project downward and strongly backward, as shown in Figure 6A. It is estimated that the atlas centrum had a length of about 88 millimeters.

The pedicals of the neuropophyses set well back from the anterior margin of the centrum. (See fig. 6A.) On the posterior borders they develop a thin process that extends upward, backward, and inward. These converge and unite medially with the neural spine of the axis arching over the anterior border of the neural canal, as well as the vertebral arterial canals. Above and posterior to the vertebral arterial canal, these processes are completely fused with the axis, leaving hardly a trace of the anterior zygapophyses of the axis or the posterior zygapophyses of the atlas. A broad anterior process of the neurapophyses extends inward above the neural canal but does

[9] Lambe, L. M., Geol. Surv. Canada, Cont. Can. Pal., vol. 3, pt. 2, 1902, p. 54, pl. 17, fig. 5.

[10] Marsh, O. C., Amer. Jour. Sci., ser. 3, vol. 44, 1892, p. 173, pl. 3, fig. 3.

[11] Hennig, Edwin, Naturw. Wochenschr., new ser., vol. 18, no. 51, 1919, p. 771.

[12] Hay, O. P., Second Bibliography of the Fossil Vertebrata of North America, vol. 2, 1919, p. 237.

[13] Trans. Roy. Soc. Canada, vol. 15, 1921, pp. 93, 94, pl. 1, fig. 1.

[14] A monograph of the Fossil Reptilia of the Liassic formation, pt. 2, Paleontographical Soc., 1863.

not meet its fellow of the opposite side, thus leaving the spinal cord exposed for a considerable space, a condition also found in *Scelidosaurus* as well as in the ceratopsian dinosaurs.

The axis centrum is heavier than that of the atlas but apparently subequal in length. The posterior articular face is deeply cupped,

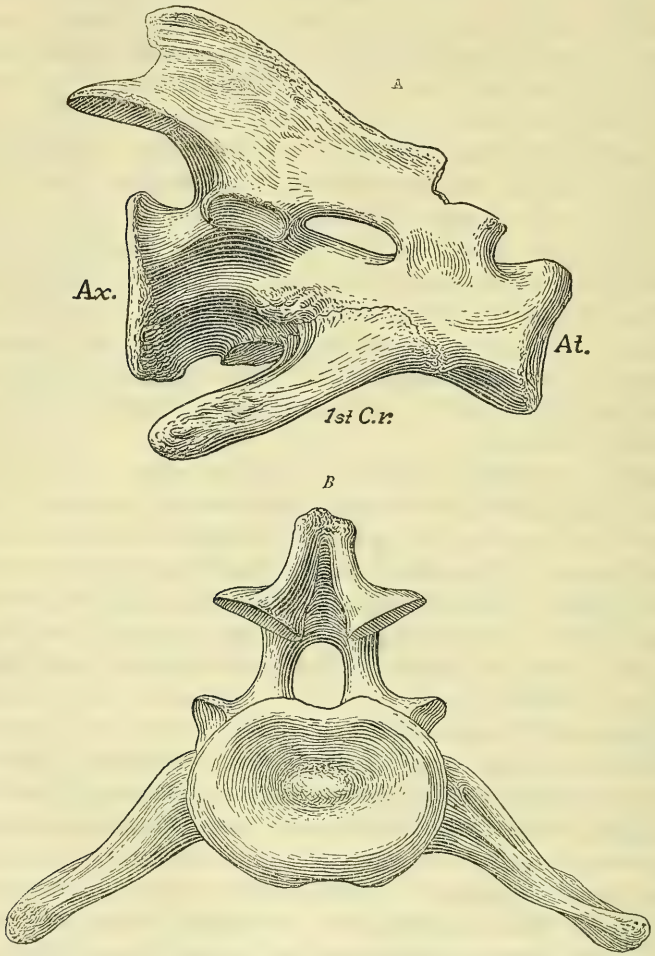

FIGURE 6.—ATLAS AND AXIS OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. *A*, LATERAL VIEW; *B*, POSTERIOR VIEW OF AXIS, ABOUT ONE-THIRD NATURAL SIZE. *At.*, ATLAS; *Ax.*, AXIS; *1st C. R.*, FIRST CERVICAL RIB

as shown in Figure 6B. The lateral surfaces are concave and there is a heavy median keel, on either side of which, on the anterior half, are well developed parapophysial facets. The neural arch is low and massive. The postzygapophyses strongly overhang the posterior border of the centrum. Their articular faces are flat and es-

pecially expanded. The diapophyses are short and stout, extending outward at nearly right angles from the extreme lower side of the arch. They have ovate, slightly cupped articular ends that look downward and backward.

Measurements of atlas and axis

	Mm.
Greatest length of combined centra	165
Greatest length of atlas centrum (estimated)	88
Greatest length of axis	77
Greatest height of axis centrum	68
Greatest height of atlas centrum	58
Greatest length of first crevical rib	126

Cervicals posterior to the axis.—In addition to the atlas and axis there are three cervical vertebrae, one of which can be positively identified as the third and the remaining two are provisionally regarded as the fifth and seventh respectively. The third, except for its slightly increased size, has the proportions of the axis, as shown in Figure 7. The cupped parapophysial facet has moved upward on

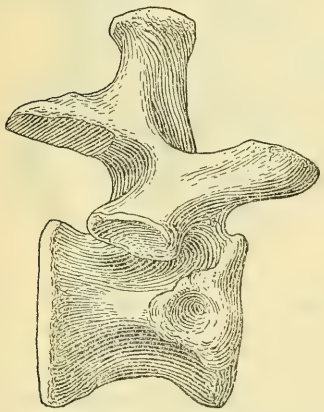

FIGURE 7.—THIRD CERVICAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. LATERAL VIEW. ONE-THIRD NATURAL SIZE

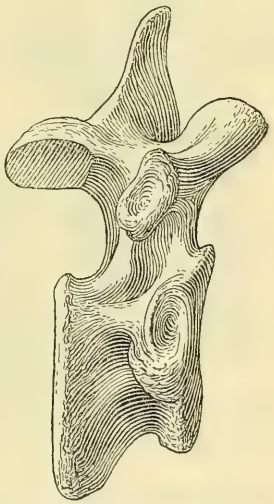

FIGURE 8.—FIFTH? CERVICAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. LATERAL VIEW. ONE-THIRD NATURAL SIZE

the median anterior border of the centrum and the diapophyses have increased in length and general robustness. The top of the low stout spine is somewhat expanded transversely. The centra of all the cervicals are deeply amphicoelous. In the center of these cupped ends, both front and back, are transversely elongated notochordal projections that stand out prominently from the surrounding surface.

The vertebra regarded as the fifth of the cervical series is illustrated in Figure 8. It differs considerably from those both anterior and posterior to it in having a much shorter centrum, and narrower (antero-posteriorly) neural arch, and in having the anterior articular face at a higher level than the posterior articular, as may be seen in the figure. In an articulated series, this would give the neck a decided upward inflection. This feature is little if at all developed in the other cervicals. The neutral spine also shows the peculiarity of being very thin antero-posteriorly, whereas the spines of the other cervicals both front and back are of the usual stout form.

The sides of all the cervicals are deeply concave and there is no evidence of a ventral keel. The vertebræ increase in general robustness posteriorly; the diapophyses become slightly longer and heavier,

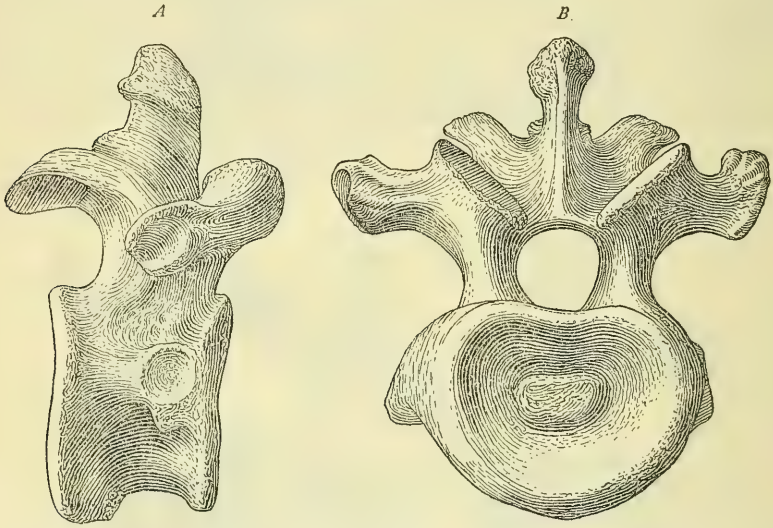

FIGURE 9.—SEVENTH? CERVICAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. No. 11868, U.S.N.M. *A*, LATERAL VIEW; *B*, ANTERIOR VIEW. BOTH FIGURES ONE-THIRD NATURAL SIZE

the neural canal increases somewhat in size, and the pleuropophyses gradually rise on the side of the centra as is shown in Figure 9A. The spines, however, do not increase in height posteriorly.

The complete cervical series is as yet unknown in any of the armored dinosaurs from the Upper Cretaceous. Nopsca recognized six as cervical in the articulated skeleton of *Scolosaurus* in the British Museum, and the atlas and axis and perhaps more were missing from the anterior end of the articulated column. Thus there were at least eight. Gilmore regarded *Stegosaurus* as having twelve in the complete cervical series.

Measurements

	Cervicals		
	Third	Fifth	Seventh
	Mm.	*Mm.*	*Mm.*
Greatest length of centrum	82. 5	55	66
Greatest width of centrum	107	120	123
Greatest height over all	[1] 150	172	187
Width of neural canal	39	53	48

[1] Estimated.

Dorsal vertebrae.—There are 10 vertebrae of the dorsal region representing all parts of the column. About half of these are perfectly preserved, while the other half are either much distorted by crushing or important parts are missing.

The centra are relatively short and amphicoelous throughout the series; articular faces expanded and sides deeply excavated (fig. 10A). In the dorsals the transverse diameter of the centra always

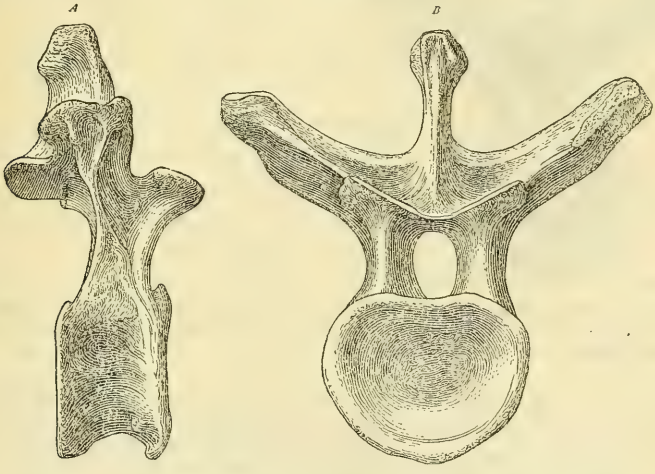

FIGURE 10.—ANTERIOR DORSAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. *A*, LATERAL VIEW; *B*, ANTERIOR VIEW. BOTH FIGURES ONE-THIRD NATURAL SIZE

exceeds the vertical. The centra of greatest length are near the middle of the thoracic region. In the anterior half of the column the centra have a well developed median keel bordered on either side by shallow depressions. Posteriorly, however, the distinct keel disappears and the bottom of the centra is obtusely rounded. The neural arch is low and massive throughout (fig. 10B). The transverse processes are massive, of moderate length, and project obliquely upward but not so sharply as in *Stegosaurus*. They are deeply

cupped on their outer ends for close union with the ribs. In the posterior part of the series, these processes become so fully fused that the line of demarcation between the two elements can be distinguished with great difficulty, as shown in Figure 11.

In describing *Ankylosaurus*, Brown [15] points out that "in the four posterior dorsals preserved the ribs are firmly coossified to the vertebra." Three such vertebrae are present in this specimen, but this condition probably continues in those dorsals ankylosed with the sacrals. In *Panoplosaurus mirus* all of the ribs are said to be free.

The pleuropophyses gradually rise from the top of the mid part of the centrum to a point well up on the side of the arch. In the mid-dorsal region this facet is large and cupped. The neural canal is large and vertically oval but diminishes slightly in size posteriorly.

The anterior zygapophyses are much enlarged, trough-like, and united. The posterior zygapophyses have flattened articular faces,

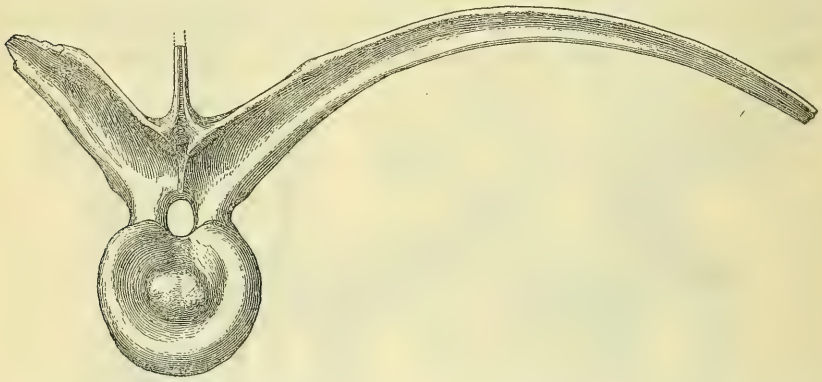

FIGURE 11.—POSTERIOR DORSAL VERTEBRA WITH COOSSIFIED RIB OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. POSTERIOR VIEW. ABOUT ONE-FIFTH NATURAL SIZE

not rounded as in *Ankylosaurus*, and are distinct one from the other. The spines are relatively short, thin plates with transversely enlarged extremities, this enlargement being mainly on the posterior half.

The last free dorsal is peculiar in having the posterior articular face of the centrum smaller than the anterior, and also in having it raised to a higher level, which gives the vertebra an inclined appearance when viewed laterally. In the articulated backbone this would serve to accentuate the curve of the sacro-lumbar region. The notochordal projections, if they may be so designated, described in the cervicals, persist throughout the dorsal series, gradually increasing in size posteriorly. On the most posterior vertebra they occupy fully one-half of the entire articular face of the centrum.

[15] Bull. Amer. Mus. Nat. Hist., vol. 24, 1908. p. 193.

The transverse processes of the posterior dorsals appear, when viewed from the end, to originate far down on the side of the arch, but this is brought about by the fusion of the rib heads with the parapophyses, as shown in Figure 11, whereas in reality these processes originate some distance above. The posterior dorsals of *Ankylosaurus* are even more deceptive in this respect.

Measurements of dorsal vertebrae

	Anterior	Middle	Posterior
	Mm.	*Mm.*	*Mm.*
Greatest length of centrum	65	83	68
Greatest height of centrum, posterior end	97	95	100. 5
Greatest height over all	235	[1] 258	
Greatest expanse of transverse process	248	200	180

[1] Estimated.

Sacrum.—The sacrum of *Palaeoscincus rugosidens* consists of three sacral vertebrae in the primary sacrum, four presacrals (sacro-lumbars), and two sacro-caudals, all coalesced into a synsacrum complex of nine vertebrae in all. This is the same number and arrangement as in *Nodosaurus textilus* as described by Lull.[16] In *P. rugosidens* only the ventral surface of the sacrum is preserved, as shown in Plate 4. The upper side was eroded away before the final entombment of the skeleton. Viewed laterally the sacrum complex is bowed from end to end, especially posteriorly. The centra are so firmly coössified that the line of demarcation between successive vertebrae has practically been obliterated. The usual dilation of the ends of the centra is missing, hence no clue is to be had from that feature. Ventrally the sacrum is characterized by a longitudinal groove that traverses all except the first two sacro-dorsals and the last sacro-caudal.

The anterior coösified centra are relatively long and slender, broadening into a wide plate in the true sacral region, narrowing again in the sacro-caudal region. The three sacrals bear long, relatively slender ribs which are coössified to their respective centra, their lower margins being on the same level as that of the centra. The expanded distal ends are coössified, especially one and two, together forming the sacricostal yoke which abuts against the inner side of the ilium. Dorsally these ribs appear to have been continuous with the diapophysial lamina.

The transverse processes are lacking in the first sacro-caudal, but in the second they are preserved as long, slender processes origi-

[16] Amer. Journ. Sci., vol. 1, 1921, p. 102.

nating on the posterior half of the centrum extending outward, strongly backward, and slightly upward. These processes are T-shaped in cross section. The first pair may have abutted against the posterior border of the ilium as in *Nodosaurus*.

Measurements

	Mm.
Greatest length of sacral series	725
Greatest width across sacral ribs	540

Caudal vertebrae. There are 11 free caudal vertebrae present but these do not form a continuous series, at least five being necessary to fill the gaps in addition to an unknown number missing from the distal end. In the complete caudal series of *Dyoplosaurus*, Parks [17] recognized no less than 23 vertebrae, and it seems quite probable that the animal here described may have had an equal number.

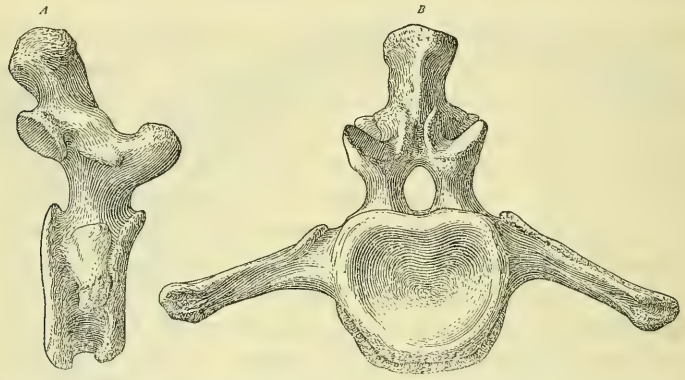

FIGURE 12.—THIRD CAUDAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. *A*, LATERAL VIEW; *B*, ANTERIOR VIEW. BOTH FIGURES ABOUT ONE-THIRD NATURAL SIZE

The caudal centra are short, articular faces wider than high, amphicoelous, and having the notochordal protuberances at the center as in the presacrals. The sides of the centra are deeply excavated in those vertebrae having transverse processes, but more moderately so posteriorly. A single vertebra from the region posterior to the middle of the tail is considerably longer than any that precede it.

The transverse processes are long, horizontal, and, excepting the anterior three which articulate in part with the side of the arch, all spring from the superior side of the centrum; posteriorly their length decreases regularly. The transverse processes of the first three have slightly expanded ends (fig. 12). Those of the second caudal are directly slightly forward and are in contact with those of the first on the outer border where there is a rugose roughening. Similarly, number one was in contact with the last sacro-caudal.

[17] Univ. Toronto Studies, Geol. ser., 1924, pp. 14–16.

Whether these combined outer ends gave support to the ilium cannot be determined from this specimen. The wedge shape of the anterior centra, especially the third (fig. 12A), indicates a rapidly dropping tail, a feature also found in the Jurassic *Stegosaurus*.

In all of the anterior caudals the arch is massive and the short spines are heavy, angularly rounded in cross-section with expanded extremities. In the mid-caudal region, however, the spines are flattened with slight transverse dilation of their upper ends (fig. 13.) All of the spines on the anterior two-thirds of the tail strongly overhang the centra. In the smallest vertebra present the spine no longer stands upright but persists as a low, rounded ridge without lateral expansion, terminating posteriorly in a bluntly rounded point projecting directly backward beyond the posterior zygapophyses which are fast becoming sessile.

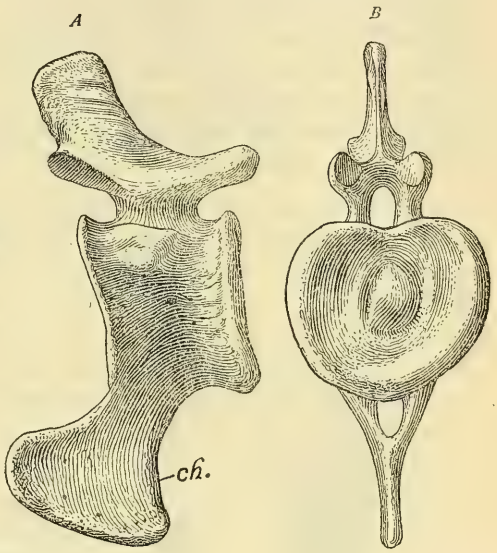

FIGURE 13.—MEDIAN CAUDAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. *A*, LATERAL VIEW; *B*, ANTERIOR VIEW; *Ch.*, CHEVRON. BOTH FIGURES ABOUT ONE-THIRD NATURAL SIZE

No indication of a "tail-club" was found and but two vertebrae from the anterior half of the tail showed indication of ankylosis. These have their centra fully coössified, a condition, as indicated by the deformed nature of the bones, brought about by an injury.

Measurements of caudal vertebrae

No. of vertebra in series	Greatest length of centra	Greatest width of centra (post. end)	Greatest width of transverse processes	Greatest height over all	Remarks
	Mm.	*Mm.*	*Mm.*	*Mm.*	
1	57	107	404	211	
2	52	107	367	208	
3	49	103	310	200	
5(?)	44	100	216	190	
7(?)	57	--------	194	--------	Coössified.
8(?)	58	85	183	172	
9(?)	44	88	--------	--------	Centrum only.
11(?) or 12(?)	56	85	90	107	
14(?)	52	86	--------	--------	
15(?)	56	81	--------	135	
(?)	66	66	--------	87	

Chevron.—The first chevron is carried on the fourth caudal as in *Dyoplosaurus* and all are coösified with the vertebral centra. The anterior chevrons are intervertebral but posteriorly articulate entirely with their respective vertebrae. These bones of the anterior half of the tail have the proximal articular ends bridged across with bone but more posteriorly these ends are distinct. The anterior chevrons are long and bladelike with slightly expanded ends, but as the shaft shortens posteriorly their distal ends become correspondingly enlarged as shown in Figure 13.

The haemal canal is large anteriorly but becomes very small in the posterior part of the series.

Ribs.—There are parts of no less than 28 ribs present, half of which are complete. These pertain to both right and left sides representing all sections of the body. The outstanding features of the ribs are their general massiveness and wide spread. The thoracic ribs, when articulated, rise as high as the top of the spines, thus forming an exceedingly broad back and great girth.

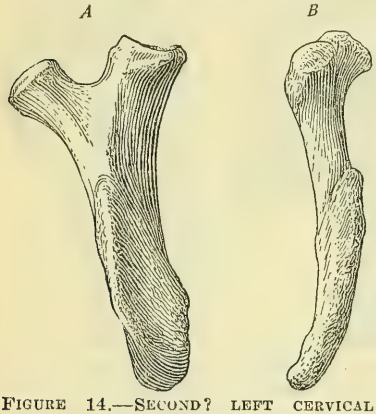

FIGURE 14.—SECOND? LEFT CERVICAL RIB OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. *A*, LATERAL VIEW; *B*, VENTRAL VIEW. BOTH FIGURES ONE-THIRD NATURAL SIZE

Of the above-mentioned ribs six are regarded as cervical, the first pair being firmly coössified with the coalesced atlas and axis, as shown in Figure 6. They are single headed, with widely expanded ends which not only articulate with the centrum of the atlas but are in contact with the anterior end of the axis as well. The shaft is stout, sub-ovate in cross-section, with a bluntly pointed distal extremity. The rib of the right side is 130 millimeters long.

The cervical rib illustrated in Figure 14 is tentatively identified as the second of the left side. It was found widely separated from the axis, but the spread of the tubercular and capitular processes is in agreement with the dia- and parapophysial facets on the axis. Its slightly increased length over the first cervical rib corroborates this assignment. On the other hand, when compared with the second cervical rib of *Panoplosaurus mirus* as described by Sternberg,[18] such differences are found, especially in the proximal end, as to raise a question as to its really being the second of the series. This rib has a greatest length over all of 143 millimeters. The tubercular and capitular processes are of about equal length, the former as usual

[18] Trans. Roy. Soc. Canada, vol. 15, 1921, pl. 1, figs. 3.

being much the stouter. The shaft is flattened, the distal fourth curved slightly inward and terminated with a bluntly rounded end. The external surface is angularly convex transversely. On the external surface there is a longitudinal ridge-like roughening of the bone which occupies its distal two-thirds, as shown in Figure 14B. The proximal half of a larger rib, probably the fourth or fifth of the left side, records the following changes: The capitular process has become much longer than the tubercular, the shaft is more rounded, and the posterior side deeply concave. On the external surface the roughened longitudinal area has assumed a somewhat lower position on the shaft; the distal end is missing. The proximal has a spread of 101 millimeters as compared with 70 millimeters in the second.

The proximal end of a right rib farther back in the series displays a decided lengthening of the capitular process which is slender and nearly circular in cross section. A right rib from the posterior part of the cervical series much curved from end to end is illustrated in Figure 15C. The distal extremity is missing, but from the tapering character of the bone above the break it is quite evident that it was pointed. On the upper half the posterior margin extends backward from the heavier shaft, forming a deep longitudinal concavity on the posterior side. This rib, measured over the curve from the top of the tuberculum, is estimated to have a length of 375 millimeters and a width at the center of 40 millimeters; the broken distal end measures 11 millimeters antero-posteriorly.

A complete anterior rib of the left side which may possibly represent the first throracic rib is illustrated in Figure 15B. That it may have been joined to the sternum is indicated by its slightly enlarged distal end. In cross section below the tuberculum, the shaft has a peculiar shape in so much as the usual elliptical rib has its outer surface developed posteriorly into a thin flange that forms a deep longitudinal concavity on the posterior side. The tuberculum is merged into and extends inward on the upper edge of the capitular process, which is nearly as wide and heavy as the shaft itself. This bone, measured over the curve from the tuberculum, has a length of 510 millimeters.

The longest rib of the entire series is shown in Figure 15A. It measures 890 millimeters in length and is heavy and massive throughout. The upper portion is T-shaped in cross section. At a point midway between the middle and the distal end is an enlarged roughened area which morphologically appears to correspond to the position of an uncinate process. Whether these processes existed as distinct elements in the armored Dinosauria has not yet been determined. Nopsca[19] attributed the flangelike overhang of the anterior thoracic

[19] Geologica Hungarica, Budapest, vol. 1, 1928, p. 56.

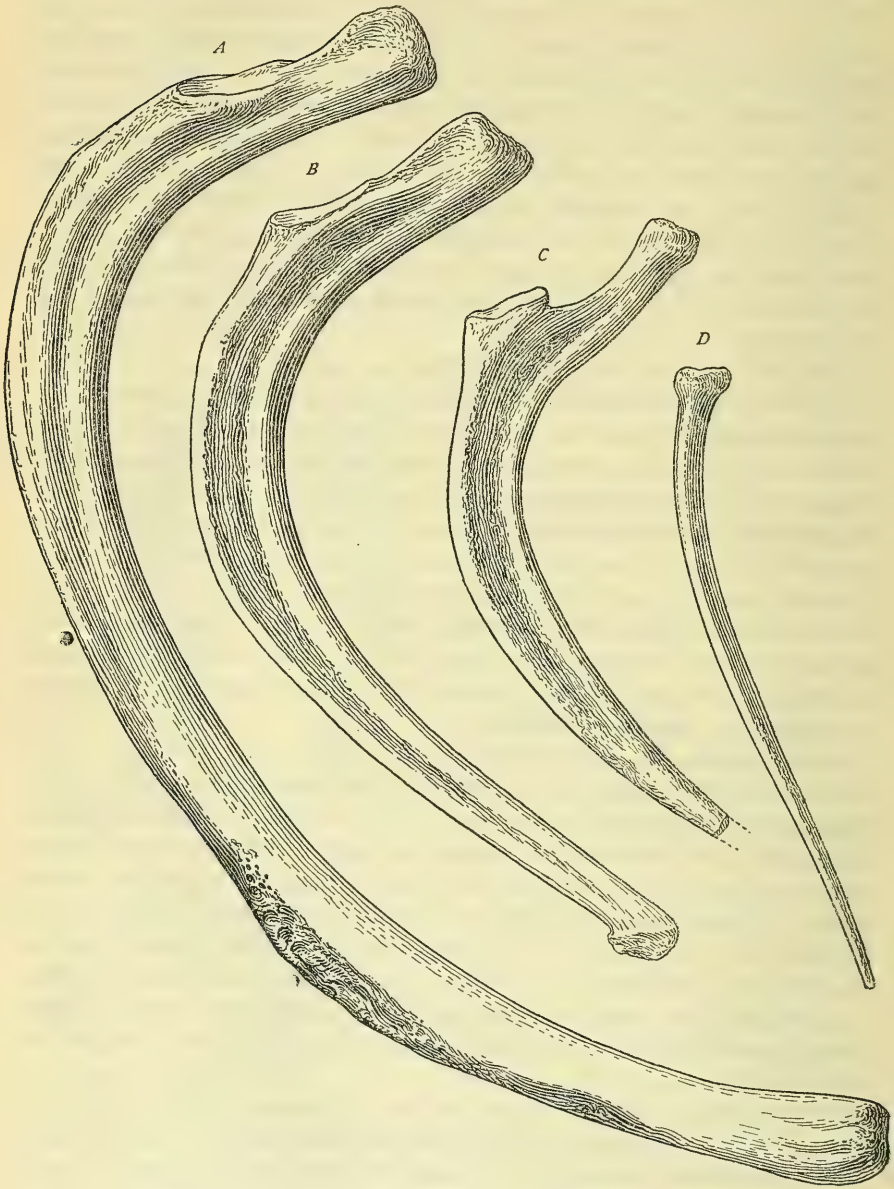

FIGURE 15.—RIBS OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. *A*, THORACIC RIB; *B*, FIRST? THORACIC RIB; *C*, POSTERIOR CERVICAL RIB; *D*, RIB OF UNDETERMINED POSITION. ALL FIGURES ABOUT ONE-FOURTH NATURAL SIZE

ribs as representing the *processus uncinatus*, but I believe he was mistaken in this. A more logical explanation, it seems to me, is the one given by Brown that this enlarged area on the anterior ribs may have served for attachment of the heavy shoulder muscles in *Ankylosaurus*.

Posteriorly the ribs become progressively more slender with pointed distal extremities. There is evidence that at least three of the posterior dorsals had the ribs fully coössified with the neural arch as shown in Figure 11. So complete is this coalescence that the line of demarcation between the two bones can scarcely be detected. These most posterior ribs are exceptionally wide and thin below the T-shaped section of their upper portion.

In addition to the above-described ribs there are three single-headed ribs of the type of the one illustrated in Figure 15D. They have a roughened rugose articular proximal end slightly bowed from end to end, shaft of moderate width, tapering to a pointed end. I am unable to determine their proper position in the skeleton. That they do not pertain to the sacro-dorsals seems to be indicated by the flat, wide ends found attached to the blade of the ilium (fig. 3, pl. 7), whereas these have narrow pointed ends. The most perfect one of the three which lacks the extreme distal end measures 350 millimeters in length.

Ilium.—The preacetabular portion of the right ilium and a few scattered, much-worn fragments are all that was preserved of the ilia. This anterior blade is platelike, thickened, nearly straight on the inner border, gradually thinning toward the anterior and outer margins, the latter presenting a sharp edge. The anterior end is obtusely pointed, its most anterior projection being well toward the inner side of the bone; externally the border rounds off toward the laternal margin as shown in Plate 7, Figure 3. The upper surface of this portion is smooth, slightly convex from side to side; the under surface is concave both transversely and antero-posteriorly.

There is no indication of dermal plates having been united to the superior surfaces of the ilium as in *Stegopelta*, although on the outer half of the mid part of this section of the ilium there are shallow transverse grooves, probably for blood vessels suggesting a cutaneous investment that was closely applied to this surface of the ilium. Lull [20] has noted a similar condition on the ilia of *Nodosaurus*.

On the ventral side the distal ends of three posterior ribs remain securely coalesced with this surface of the ilium as shown in Plate 7, Figure 3. The end of the anterior rib projects slightly beyond the margin of the ilium, the remaining two terminating an inch or more inside its border.

[20] Lull R. S., Amer. Journ. Sci., vol. 1, 1921, p. 105.

Pubis.—The small bone illustrated in Figure 16 is regarded as the right pubis. It is a remarkably small bone for so large an animal, the whole prepubic portion measuring only 140 millimeters in length, less than one-half the length of the *Stegopelta* pubis.[21] The anterior portion is a thin vertical blade of bone terminated anteriorly by a slightly thickened rugose end that is rounded off from above downward. On the internal surface at about its mid length the postpubis branches off, continuing backward and downward. The postpubic branch terminates in a vertically expanded end that in this specimen is perfectly preserved (fig. 16). On the outer side much of the surface has been eaten away, leaving one at a loss to understand where and how this bone articulated with the ilium, as there is no indication of an enlarged articular area.

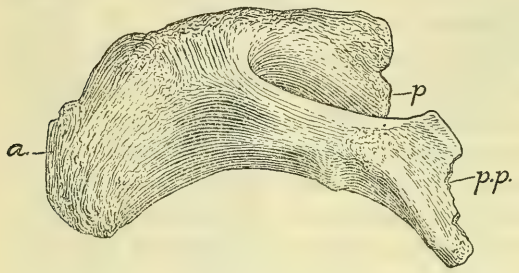

FIGURE 16.—RIGHT PUBIS OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. LATERAL VIEW. *A.*, ANTERIOR END; *p.*, POSTERIOR END; *Pp.*, POSTPUBIS. ONE-THIRD NATURAL SIZE

The small size of the pubis in these Upper Cretaceous armored dinosaurs has been indicated by Nopcsa in *Scolosaurus*, but it was so poorly preserved that he could not determine its shape. *Ankylosaurus* also has a very much reduced pubis[22] apparently coossified to the ischium and Nopcsa remarks that "it neither seems very large in *Polacanthus*." The outer surface is much roughened.

Ischia.—Both ischia are present, the left one being complete, the right lacking its distal fourth. The ischium is a moderately long curved bone having a widely expanded proximal and a bluntly pointed distal extremity. On the outer surface the proximal end is concave fore and aft and forms a part of the acetabulum. The acetabular margin is unusually straight. Below this end the shaft is flattened transversely and gradually decreases in width toward the distal end, the taper becoming more pronounced a little below the mid-length where the bone also bends downward, as shown in Figure 17. A flat roughened area on the external surface at this bend indicates the point of attachment of an important ligament. On the inner side the surface of the bone gives no indication that it was in contact on the midline with its fellow of the opposite side though doubtless there was a cartilaginous union of the two.

[21] Moodie, R. L., Kans. Univ. Sci. Bull., vol. 5, No. 14, 1910, p. 265, pl. 58, fig. 1.
[22] Romer, A. S., Acta Zoologica, vol. 8, 1927, fig. 8, p. 243.

Measurements

	Mm.
Greatest length in a straight line	570
Greatest width of proximal end	275
Greatest width of distal end	23

Dermal armor.—Intermingled with the scattered parts of the skeleton some fifty dermal bones of this one individual were collected. These present a variety of kinds, spines, large and small; coössified plates; rounded scutes, with and without keels; and numerous granular ossifications. Although this specimen will contribute but little to our knowledge of the arrangement of the dermal armor, it does give a considerable insight into the character of the osseous dermal covering.

Comparison of these scattered plates and spines with those of *Palaeoscincus* in the American Museum of Natural History, New York, where the armor has been preserved *in situ* enables me to recognize the proper location of many of these scattered bones. Furthermore the close similarity in shape, size, and association makes it at once apparent that we are dealing here with two animals that are generically alike.

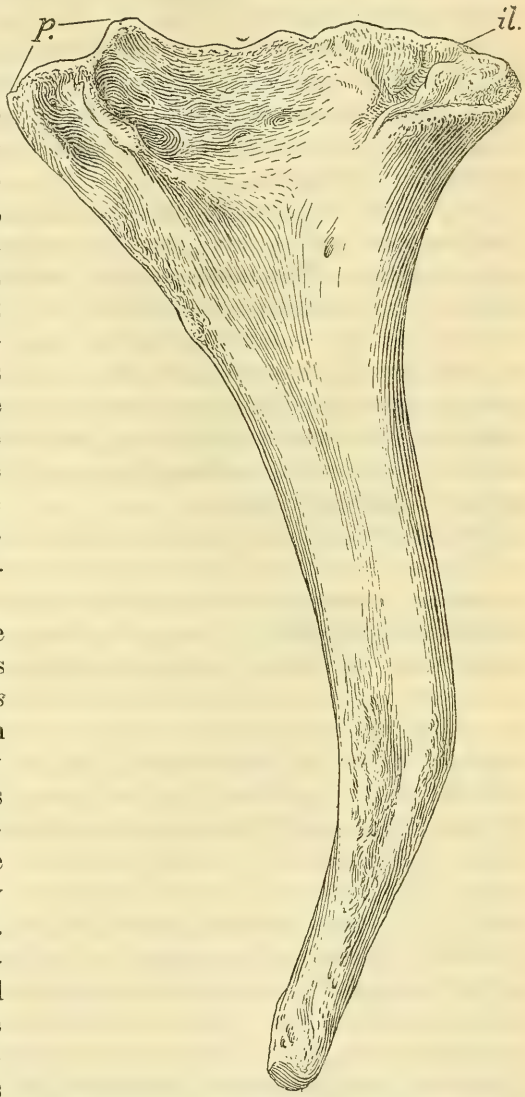

FIGURE 17.—LEFT ISCHIUM OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. LATERAL VIEW. *Il.*, ARTICULATING SURFACE FOR ILIUM; *P.*, ARTICULATING SURFACE FOR THE PUBIS. ABOUT ONE-FOURTH NATURAL SIZE

Neck plates.—The dermal armature covering the neck is represented by three plates each composed of either two or three coössified bony scutes. These are illustrated in Plate 5. The smallest of these plates, a complex of three scutes (fig. 3, pl. 5) is tentatively regarded

as the right half of the first transverse ring. The largest plate, a composite of two paired scutes, is identified as the median part of the second ring (fig. 1, pl. 5); the third plate consisting of two scutes is provisionally regarded as completing the right half of the second ring (fig. 2, pl. 5).

The articulated *Palaeoscincus* skeleton illustrated by Matthew [23] (pl. 8, fig. 1) shows the rings over the neck to consist of six scutes each, the narrowest ring lying in front, and it is largely on the evidence of this specimen that the provisional identification of these elements is made.

The upper surfaces of these plates are roughened by irregular, shallow vascular pits and grooves that are so distinctive of all dermal elements. The under surfaces are fairly smooth and show no traces of the coalescence of the individual scutes further than a slight swelling of the bone following the course of the sutural union, but on the dorsal surfaces their line of junction is marked by deep straight grooves. Each scute has a low longitudinal keel that originates on the front border, rising posteriorly where it terminates in an obtusely pointed overhanging, spine-like projection. These keels are asymmetrically placed.

The first ring in its entirety evidently consists of six scutes divided in this individual at the center into two plates. It appears very probable, however, that other individuals might have the two halves fused at the middle into one continuous ring of bone, although Sternberg found the same divided condition in the type of *Edmontonia longiceps*.[24] The ring is broadly arched and has a length, measured in a straight line across the arch, of 350 millimeters, a width on the median line of 90 millimeters. The medial scute is rectangular in outline with its greatest diameter transverse. Viewed from above, however, this scute is pentagonal in shape due to the low lying projecting spine, which strongly overhangs the posterior border of the scute. The keel on this scute is placed nearest the external side and is slightly divergent from the median line as it runs backward. The median scute has the keel nearest to the inner side, and the overhanging spinous projection is more rounded and pointed than on the scute previously described. The outer of the three scutes is subrhombic in outline when viewed from above and the keel which originates on the inner, anterior corner, pursues a diagonal course outward and backward, the conical spine strongly overhanging its outer border.

On the anterior border at the junction of the scutes there are roughened indentations that suggest the points of attachment of smaller dermal elements. Otherwise this border is beveled from

[23] Matthew, W. D., Natural History, vol. 22, 1922, pp. 334–335.
[24] Sternberg, C. M., Trans. Royal Soc. Canada, vol. 22, 1928, sec. 4, p. 104.

below upwards, leaving a narrow rounded edge whose surface is slightly roughened. The scutes vary from 26 to 36 millimeters in thickness around their borders. From the rounded character of the outer border of the third or lateral scute, it seems quite probable that it represents the lateral termination of the first ring.

The two coössified scutes, shown in Figure 1, Plate 5, are thought to represent the median pair of the second dermal row which in this instance are fully coössified on the median line as in *Panoplosaurus*. These scutes in transverse curvature, thickness, outline of posterior border, and keel development show a close resemblance to the homologous elements of *Panoplosaurus mirus*. In proportion and outline as a whole and in minor features they show many dissimilarities and strongly suggest that differences found in the armor of *Palaeoscincus* and *Panoplosaurus* when fully known will greatly assist in distinguishing these genera.

The median coössified plates of the second row measured in a straight line across the ventral side have a greatest transverse width of 390 millimeters; on the median line a length antero-posteriorly of 130 millimeters. The keels of these scutes are placed nearest the outer border, whereas in *Panoplosaurus* they are near the inner edge. The posterior end of the keel develops a low, obtusely rounded spine that overhangs this edge.

The third plate consisting of the two coössified scutes shown in Figure 2, Plate 5, is identified as completing the right half of the second ring. That the smaller one represents a lateral scute seems to be indicated by the rounded outer border and the strong diagonal trend of the keel.

Spined scutes.—Massive, long, sharply pointed spined scutes, such as are found on the shoulders and along the sides of *Palaeoscincus* (see pl. 8) are present, and are illustrated in Plate 6, Figures 1, 2, 3, and 4.

A pair of moderately sized spinous scutes apparently corresponding to those lateral to the ends of the second transverse ring (fig. 3, pl. 6) in the *Palaeoscincus* skeleton are in perfect preservation. Their bases are subovate in outline, measuring 205 millimeters in the longest diameter and 133 millimeters in the shortest. These ends are deeply concave and around the borders a rugose band indicates clearly the depth of their insertion in the integumentary covering. On the superior surface, a high, triangular-shaped spinous keel is developed, overhanging the basal portion. Over all, this scute has a greatest height of 290 millimeters. The surface of these bones is covered by the usual shallow vascular pits and grooves.

A single scute, the largest of the series, doubtless corresponds to the second in this row of lateral spines, and occupies a position over

the left shoulder and lateral to the third transverse ring in the *Palaeoscincus* skeleton (pl. 6, fig. 1). Viewed from below the base of this scute is subrectangular in outline, having a greatest length of 350 millimeters, and a width at the center of 120 millimeters. This surface is traversed by a median longitudinal depression that gradually deepens toward the spinous end. The base is concave from end to end with a torqued posterior end. The shape of the basal surface is probably an adaptation in better conformation with the underlying bones of the shoulder region. Its depth of insertion in the skin is clearly indicated by a rugosely roughened band that extends entirely around the basal portion of the scute. On the dorsal surface is a high, sharp edged keel that has its origin on the posterior internal angle and extends diagonally across the scute. This keel gradually increases in height from its point of origin terminating in a high, sharply-pointed but compressed spine that strongly overhangs the posterior basal part of the scute. Measured from the base to the tip this spine is 242 millimeters long.

A dermal plate illustrated by Lambe [25] and provisionally associated with *Euoplocephalus tutus*, may, on account of its close resemblance to the plate just described, be quite certainly referred to the genus *Palaeoscincus*.

A pair of large triangular shaped, sharply pointed spines, each coössified with a smaller scute carrying a very much smaller and blunter spine undoubtedly represent the next two spines of the lateral series which project outward from the side of the body above the fore leg. In *Palaeoscincus*, however, these two elements appear to remain distinct. These coössified plates have a greatest basal length of 460 millimeters. The taller spine measures 400 millimeters in height, the shorter only 180 millimeters. These spines are figured in Plate 6, Figure 4.

Among the dermal elements there are three other scutes which may be classified as spines but no clue has yet been obtained as to their position. These are of much smaller size than those previously described and one is shown in Plate 6, Figure 2. These have subovate, concavely excavated bases, low asymmetrically placed keels, that pass into two obtusely pointed compressed or angularly rounded spines that project backward at a low angle. Two of these are the right and left elements of a pair.

The position of this lateral row of spined dermal elements in the *Palaeoscincus*, skeleton (pl. 8), having the spines projecting outward and forward seems entirely opposed to a natural placing. In such a position they would have been a source of constant annoyance and trouble to the animal by constantly catching on small trees

[25] Contrib. Canadian Paleont., vol. 3, 1902, p. 57, fig. 13.

and shrubbery. Had they not been found *in situ*, a study of living creatures on the basis of analogy would not have placed them as they are. Reversed in position or at most having the spines directed straight out from the body, would be more in accord with those spined quadrupedal creatures known to-day. Furthermore, the specimen of *Scolosaurus* in the British Museum has somewhat similar scutes preserved along the neck *in situ*, and these are in accord with living lizards. It is not my purpose to question the position of the spines in the *Palaeoscincus* skeleton but I do seriously doubt that during the life of the animal they occupied their present forwardly directed position.

Sacral armor.—That *Palaeoscincus* had a shield-like bony covering over the sacrum as in *Nodosaurus* seems to be indicated by the presence of a number of large fragmentary plates. These plate pieces are clearly shown to consist of a number of thin, coössified scutes of several sizes and varying shapes, although most of them seem to be suboval in outline. From this fragmentary evidence it would appear that there may be a row or rows of large scutes surrounded by smaller ones. It would seem quite probable that all of these pieces may have been parts of one continuous bony shield. The nodular prominences on these scutes are almost obsolete, except for a slight thickening near the center of the largest. On the dorsal surface shallow depressions follow the course of the sutures, clearly marking out their limits. A few detached scutes of the same nature probably represent elements that pertain to nearby areas. Good examples of these are shown in Plate 7, Figure 1.

Undetermined scutes.—In addition to the dermal scutes described above and whose position on the animal has been determined with some degree of assurance, there are in the collection no less than twenty other dermal elements whose origin at this time is unknown. These scutes are of various dimensions, strongly keeled, short spined, broadly to narrowly suboval in outline, always excavated below, but usually deepest beneath the highest part of the keel or spine. On either side of the keel the external surface slopes both ways to the edge, either flatly or with a varying amount of concavity, depending largely upon the height of the keel or spine. In none of these smaller scutes does the spine overhang the border. The short spines, if they may be so designated, show a great variety of form; some are obtusely pointed, others compressed and sharp edged, others have the keel running the full length of the scute, while still others have only a nodular projection.

A great many small rounded granular ossifications were found scattered through the quarry. These filled the interspaces between the larger scutes, and are well shown in specimens of *Palaeoscincus*

and *Scolosaurus*. Similar ossifications are probably present in the skin of nearly all armored dinosaurs.

Relationships.—The genus *Palaeoscincus* falls readily into the family Nodosauridae as redefined by Lull,[26] and on the basis of the skull structure it would appear to have its closest relationships with *Panoplosaurus* and *Edmontonia*. These three genera should be grouped to form the subfamily Panoplosaurinae recently proposed by Nopsca.[27] Of the other four genera *Dyoplosaurus*, *Hierosaurus*, *Scolosaurus*, and *Stegopelta*, included by Nopsca in this subfamily, *Dyoplosaurus*, as shown by the recently discovered skull described later in this paper, should now be removed to the Ankylosaurinae. The skull structure of the three remaining genera is unknown and their precise systematic position is much in doubt. The presence in all of transverse rows of nuchal plates is one reason for their provisional retention in the Panoplosaurinae.

The definition of this subfamily may now be emended by the inclusion of the following skull characters: *Skull covered superiorly by a few large plates; orbits placed far posteriorly; lateral temporal fenestra opening laterally; nostrils latero-terminal; large quadrate+quadratojugal dermal plate absent.*

While it is not my intention to attempt a revision of the Nodosauridae, yet the study of the specimens in hand has disclosed relationships of certain American members of this family which appear worthy of record.

Dyoplosaurus, as mentioned above, is here transferred from the Panoplosaurinae to the Ankylosaurinae. In establishing this subfamily Nopsca referred to it the following genera: *Ankylosaurus*, *Euoplocephalus*, *Hoplitosaurus*, *Palaeoscincus*, *Polacanthus*, *Polacanthoides*, *Sarcolestes*. With this grouping I can agree only in part. *Ankylosaurus*, *Euoplocephalus*, *Dyoplosaurus* and *Anodontosaurus* are true members of this subfamily. On the basis of the skull structure I would amend Nopsca's definition of the Ankylosaurinae by the inclusion of the following cranial characters: *Skull covered superiorly by numerous small plates; orbits placed submedially; lateral temporal fenestra covered by dermal bone; nostrils terminal; large quadrate+quadratojugal dermal plate present.*

The other genera can not be definitely assigned on the basis of their cranial structure, the skull being unknown. *Polacanthus*, with its complete bony carapace over the sacral region and tail, compressed dermal elements unlike any found with the more typical Ankylosaurinae, will, I believe, eventually be found to belong to a distinct subfamily. The American *Hoplitosaurus* is apparently closely allied and should be grouped with *Polacanthus*.

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[27] Dinosaurierresti, Geologica Hungarica, Budapest, 1929, pt. 5, p. 70.
[26] Amer. Journ. Sci., vol. 1, February, 1921, p. 123.

In the light of our present knowledge of the genus *Nodosaurus*, I can see no justification for its inclusion in a separate subfamily, the Nodosaurinae, as proposed by Nopsca. Certainly nothing is found in its known anatomy that would prevent its assignment to the Ankylosaurinae.

The inclusion of the genus *Troödon* in the Nodosauridae by Nopcsa is so obviously in error that I take this opportunity to challenge the propriety of the assignment. *Troödon* is a typically bipedal animal with greatly reduced fore limbs, and a slender elongated scapula; premaxillary teeth present; ilium with postacetabular portion vertical and subequal in length with preacetabular portion; ischium slender, ceratopsian like; ribs slender; tibia and femur subequal in length; pes having phalanges with tongue and groove joints; a segmented abdominal cuirass.

The features briefly reviewed above are certainly an array of characters that, taken together, do not permit of the inclusion of the genus in the family Nodosauridae.

At the time of describing the osteology of *Troödon* [28] attention was directed to the curious mixture of characters found in the skull and skeleton and it was my conclusion that the relationships of *Troödon* would be best expressed by its reference to a distinct family of the Ornithopoda known as the Troödontidae, a conclusion, after again reviewing all of the evidence, that I see no reason to alter.

Chronological list of North American Nodosauridae

Name, authority, and date	Formation and locality	Nature of type
Palaeoscincus costatus Leidy, 1856	Judith River, Mont	Tooth.
Priconodon crassus Marsh, 1888	Arundel, Md	Do.
Nodosaurus textilus Marsh, 1889	Benton, Wyo	Parts of skeleton and armor.
Palaeoscincus lutus Marsh, 1892	Lance, Wyo	Tooth.
Hoplitosaurus marshi Lucas, 1901	Lakota, S. Dak	Parts of skeleton, dermal armor.
Palaeoscincus asper Lambe, 1902	Belly River, Alberta	Tooth.
Sterocephalus tutus Lambe, 1902	do	Fragment of skull, dermal armor.
Stegopelta landerensis Williston, 1905	Benton, Wyo	Parts of skeleton, dermal armor.
Ankylosaurus magnivertus Brown, 1908	Hell Creek, Mont	Skull; much of skeleton, and dermal armor.
Hierosaurus sternbergi Wieland, 1909	Niobrara, Kans	Dermal armor.
Panoplosaurus mirus Lambe, 1919	Belly River, Alberta	Skull; parts of skeleton and armor.
Dyoplosaurus acutosquameus Parks, 1924	do	Fragment of skull; posterior part of skeleton.
Scolosaurus cutleri Nopcsa, 1928	do	Much of armor and skeleton.
Edmontonia longiceps Sternberg, 1928	Edmonton, Alberta	Skull, armor, and parts of skeleton.
Anodontosaurus lambei Sternberg, 1929	do	Skull and armor.
Palaeoscincus rugosidens Gilmore, 1930	Two Medicine, Mont	Skull; much of skeleton and armor.

2. ON A SKULL OF THE GENUS DYOPLOSAURUS

Plate 9, Figures 1 and 2

In 1924 Prof. W. A. Parks [29] established the genus *Dyoplosaurus*, based on a partial but very interesting skeleton, consisting princi-

[28] Gilmore, Charles W., Bull. No. 1, University of Alberta, 1924, p. 39.
[29] Univ. Toronto Studies, No. 18, 1924, pp. 5–24.

pally of the posterior part of the axillary skeleton. Of the head only fragmentary skull parts and a few teeth remain.

In the 1928 collection from the Upper Cretaceous of Montana was a somewhat imperfect skull with four teeth which is identified as *Dyoplosaurus acutosquameus* Parks. The identification rests very largely upon similarities found in the teeth. If correct in this assignment, the specimen is of great interest in giving the first adequate knowledge of the skull structure of the genus. This specimen, No. 11892, U.S.N.M., was collected by George F. Sternberg, May 26, 1928, from the Two Medicine formation, Upper Cretaceous, from the south side of Milk River, NW. ¼ sec. 27, T. 37, N., R. 8 W., on the Blackfeet Indian Reservation, Glacier County, Mont.

The skull has its closest resemblances in *Euoplocephalus tutus* Lambe from the Belly River formation, Canada, of which two nearly perfect skulls [30] are now known in addition to the poorly preserved type.

The skull before me has the superior surfaces much checked as shown in Plate 9. It lacks the beak in front of the nares, and the palate is so badly crushed and broken that little can be determined of the mouth structure.

Viewed from above the skull is subtriangular in outline, longer than broad, and doubtless having a broadly rounded nose as in *Euoplocephalus*. The anterior half is strongly arched both anteroposteriorly and transversely. Between and behind the line of the orbits the top is depressed, especially on either side of the median line. This surface terminates posteriorly as a short overhanging crest, that is, slightly concave transversely.

Coössified dermal plates cover the surface at the top and side of the skull, thus completely obscuring all of the underlying cranial elements. The median posterior border is ornamented by a row of four small quadrangular scutes, the same number as found in the fragmentary skull of the type of *Dyoplosaurus acutosquameus*. *Ankylosaurus* also has a similar number, but in *Euoplocephalus* there are only two with a plain interspace between. The superior surface is so badly checked that the form of the scutes can be made out with great difficulty. They seem to resemble those of *Euoplocephalus* except for the lack of a large element on the nose. The surface of these scutes is undulatory, roughly rugose and covered with vascular pits and grooves. Their edges are usually angular but none has the depressed central areas found in *Euoplocephalus*. Deep circumscribing grooves set off the scutes from one another.

[30] Gilmore, C. W., The Canadian Field Naturalist, vol. 37, No. 3, 1923, p. 47; Nopcsa, F. B., Geologia Hungarica Paleontological Series, vol. 1, 1928, pp. 51–54, pl. 5.

The nearly vertical lateral surface between the orbits and the external nares is covered by two large plates, the anterior one bending over to contribute to the dorsal surface. It also forms a part of the posterior boundary of the narial opening. In *Euoplocephalus* three plates cover this area.

On the angle of the skull above each orbit is a large, blutly edged scute that slightly overhangs the eye but to a lesser degree than in *Euoplocephalus*. On each posterior external angle of the skull is a large subtriangular spinelike scute that projects prominently backward beyond the posterior border much as in *Ankylosaurus*. *Euoplocephalus* has somewhat similar protuberances but sharper edged and extending more upward. It is quite apparent that these two scutes are missing from the posterior part of the *Dyoplosaurus* skull figured by Parks.[31]

The posterior end of the skull is in fair preservation and presents a good idea of the arrangement of the occipital region, but many of the palatial elements are entirely missing, or so badly crushed that but little conception of its normal condition can be obtained.

The occipital condyle is reniform in outline and directed backward and downward. It seems quite apparent that the basal portions of the exoccipitals participate in its formation much as they do in *Stegosaurus*.[32] The condyle has a greatest transverse diameter of 54 mm., a greatest vertical diameter of 32 millimeters. The reniform shape of the condyle offers a striking contrast to the much larger subspherical condyle in *Palaeoscincus* as shown in specimen No. 11868, U.S.N.M. The foramen magnum is suboval in outline and the supraoccipital border above it deeply notched.

The basioccipital is about as long as it is broad. The ventral surface between the condyle and the expanded anterior end is broad and deeply concave with a shallow longitudinal depression occupying the central area. The basioccipital processes are very short. The exoccipitals extend outward nearly horizontal and with but little angulation posteriorly. As mentioned above, their pedicles contribute somewhat to the formation of the occipital condyle. At their outer ends they join the quadrates by means of the paraoccipital processes resting against a rugose area on the posterior sides of those bones. They do not seem to be coalesced with the paraoccipital as in *Palaeoscincus rugosidens*.

The supraoccipital can not be differentiated. The quadrate is relatively long, straight, and slender as compared with the more plate-like element in the *Palaeoscincus* skull. The thin process that extends forward and inward to meet the pterygoid is less than half

[31] Univ. Toronto Studies, No. 18, 1924, pl. 4, fig. 1.
[32] Gilmore, C. W., Bull. No. 89, U. S. Nat. Museum, 1914, p. 92, fig. 4.

the width of this process in the type of *Palaeosincus rugosidens;* likewise the articular distal end is much smaller.

There are some remnants of the palate present but a description of these would add nothing of interest.

The lateral temporal fenestra opens outward and backward between the quadrate and the enveloping armor.

Beneath and somewhat posterior to the orbit on either side is a large scute whose strongly developed keel is directed downward and outward. Its anterior outer border is acutely edged and rounded off from the front toward the back. This process completely hides the articulation of the lower jaw with the quadrate, and furnishes it with ample protection.

The orbits are suboval in outline, with a diameter anteroposteriorly of 76 millimeters and dorso-ventrally about 30 millimeters.

The skull is widest across the orbits and much constricted transversely in front, a feature that will at once distinguish *Dyoplosaurus* from *Euoplocephalus* and *Ankylosaurus.*

Measurements of the skull

	Mm.
Greatest length (estimated) median line	365
Greatest breadth across center of orbits	325
Greatest breadth immediately posterior to nares	175

Teeth.—There are five teeth preserved, one in the center of the right maxillary and the crowns of four others found in the dirt near the skull. Since there were no other animal remains with this specimen, there can be no doubt of the association. As the lower jaw was entirely missing it may be inferred that all of these teeth belong in the upper or maxillary series. The teeth are alike in form and size. Their very small size appears to be distinctive, a fact that can not be attributed to their being germ teeth as shown by one much worn tooth which has the same proportions as the unworn. Each consists of a laterally compressed crown with a long cylindrical root. The crowns measure 4.7 mm. antero-posteriorly, 4 mm. transversely through the cingulum, and about 5 mm. in height. The crown at the base has a swollen cingulum that is especially pronounced on the outer side. The edges of the teeth are denticulate, there being nine or ten denticles on each tooth, four and five respectively on either side of the apical one which is decidedly posterior to the central vertical line as shown in Figure 18. On the outer side the crown is divided into five principal columns by vertical fluting (see fig. 18B) which subsides on the internal side before reaching the cingulum. The three larger denticles are transversely flattened with acute edges, the others presenting more or less rounded points. The teeth are worn on the inner side showing that the lower teeth bite inside the

upper as would be expected. Both surfaces of the crown are marked by fine, irregular, vertical wrinkling. The line of smaller denticles on the anterior border curve inward while those of the posterior border curve outward, so that viewed from the end, the line of denticles form a sigmoid curve. The roots of the teeth are long, smooth surfaced, and subcylindrical.

These teeth have the general characteristics of other North American armored Dinosauria; that is, laterally compressed crowns with denticulated borders, basal cingulum, and long more or less cylindrical roots. Teeth are now known of the following genera: *Stegosaurus*, *Ankylosaurus*, *Stegopelta*, *Princonodon*, *Palaeoscincus*, *Panoplosaurus*, *Edmontonia*, and *Dyoplosaurus*. Compared with teeth of these various genera those belonging to the present specimen have their nearest resemblances in those of *Dyoplosaurus*.

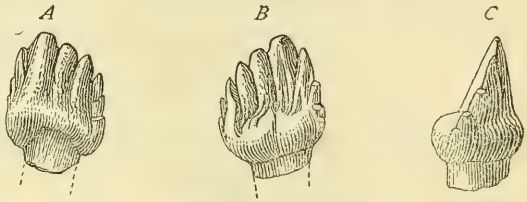


FIGURE 18.—RIGHT MAXILLARY TOOTH OF DYOPLOSAURUS ACUTOSQUAMEUS PARKS. NO. 11893, U.S.N.M. *A*, INNER VIEW; *B*, OUTER VIEW; *C*, POSTERIOR VIEW. ALL THREE TIMES NATURAL SIZE

Through the kindness of Dr. W. A. Parks, a maxillary fragment containing teeth of the type of *Dyoplosaurus acutosquameus* was loaned me for study. A direct comparison of these teeth with those of the specimen from the Two Medicine formation shows such close similarities in size, proportion, denticulation, and sculpture as to leave no doubt that the two specimens are cospecific. This maxillary fragment of the type was regarded by Parks[33] "as the anterior portion of the dentigerous region of the left maxillary," but, after comparing it with the broken maxillae of the skull here considered, I am fully convinced that it represents the posterior portion of the right maxillary. This determination is of importance as definitely fixing the position of the teeth in the jaws; that is, the highest part of the crowns are toward the posterior border. It was also found that the published illustration of the tooth does not accurately depict the original, being in error in that the denticles on the anterior border are too acutely pointed and too widely spaced. The second denticle posterior to the apical one should be lower, and the first point posterior to the apical denticle should be omitted, a fact recognized by Doctor Parks; on the posterior border at least two denticles should be added. These are now plainly shown on the specimen, though previously hidden by adhering matrix. In the Canadian tooth, however, they are barely visible from a lateral view, passing more to

[33] Univ. Toronto Studies, No. 18, 1924, p. 9.

the outer side than in the tooth of No. 11892, U.S.N.M., as shown in Figure 18A, where they are slightly visible from an inner view.

3. A NEW HORNED DINOSAUR

A fragmentary posterior portion of a ceratopsian frill is among the specimens from the Two Medicine formation collected during the summer of 1928. The presence of long horn-like processes on the posterior border of the frill shows its affinities to lie within the genus *Styracosaurus*, but these differ to such an extent in form and arrangement from those of *Styracosaurus albertensis* Lambe, from the Belly River of Alberta, as to indicate a distinct species, for which I now propose the name *Styracosaurus ovatus*, the specific name being suggested by the ovate character of the horn-like processes.

STYRACOSAURUS OVATUS, new species

Plate 10, Figure 2

Type.—Cat. No. 11869, U.S.N.M., consists of the posterior portion of the frill and numerous detached fragments. Collected by George F. Sternberg, 1928.

Type locality.—T. 37 N., R. 8 W., Milk River, Blackfeet Indian Reservation, Glacier County, Mont.

Horizon.—Two Medicine formation, Upper Cretaceous.

A nearly entire posterior end of a median frill bone with its attached processes is present. (See pl. 10, fig. 2.) This element in the ceratopsian frill has been variously designated the parietal, dermosupraoccipital, interparietal, and fused postfrontal. Sternberg [34] has recently attempted to show it to be the parietal in *Styracosaurus*, but, although it appears to represent that bone in *Protoceratops*, it certainly can not be the parietal in American horned dinosaurs, as evidenced by the juvenile *Brachyceratops* and other ceratopsian skulls in the National collections. I am unable as yet to decide certainly on its homologies, and, as a matter of expediency, shall continue to designate it the dermosupraoccipital.

The outstanding peculiarity of the skull of *Styracosaurus albertensis* is the large horn-like processes that project outward and backward from the posterior border of the frill. Somewhat similar processes are present on the frill before me. The two processes forming the hindermost pair lack their tips but it is quite evident they were not as long as in the Canadian specimen. (Compare figs. 1 and 2, pl. 10.) Furthermore, these two horns are convergent as opposed to the divergent processes in *S. albertensis*. It would seem

[34] Trans. Roy. Soc. Canada (ser. 3), vol. 21, 1921, pp. 135–143, pls. 1, 2, and 3.

that if completely preserved the extremities of these two horns would nearly meet on the median line. Those of the next pair in advance are nearly as large as the hinder pair but point outward more than backward. That there was a third pair is shown by the presence of a small lateral section of the frill, from the side of which a small, stubby process projects outward (pl. 10, fig. 2). If, as is apparent, this fragmentary part represents the third pair, these processes have their origin considerably forward of the second pair as shown by the smooth, rounded border between them. In *S. albertensis* these processes are relatively shorter, curved, and twinned with the second pair at the base.

The central part of the posterior border of the interparietal between the posterior pair of processes is thick and rounded and when viewed from above (pl. 10. fig. 2) displays a decided notch on the median line. That large fontanelles were present on either side of a median bar as in *S. albertensis* is shown by the rapid thinning of the bone on the anterior borders on either side of the middle, and also of the posterior portion of the bar which is preserved. This part of the median bar is broadly rounded transversely on the upper side but flattened beneath.

The upper and lower surfaces of the frill parts are marked by the usual vascular grooves. The horn-like processes are much flattened above and below and cross sections taken from almost any part would be broadly ovate in cross section.

Measurements

	Mm.
Greatest width from tip to tip of second pair of processes	800
Greatest length of right process of second pair	295
Greatest width of same at base	93
Greatest length of shortest process	108
Greatest width of median notch	57

Reference of the present specimen to a new species on such fragmentary material is a procedure that may be open to some question, especially where the specific characters are based upon structures which may be subject to much variation. However, the difference noted in these hornlike processes, except for their much greater size, appear to be comparable to the changes found in the different species of living horned lizards (*Phrynosoma*). In the latter case, however, the differences in horn structure are confirmed by other characters such as coloration and scutellation, features that of course are not available to the paleontologist. However, in establishing this species on the available material, fragmentary though it may be, it is with the hope that more complete specimens will disclose other and perhaps more stable characters.

EXPLANATION OF PLATES

PLATE 1

View of the excavation where the skeleton of *Palaeoscincus rugosidens* was collected. In the middle foreground is a large plastered block containing the sacrum. Photograph by George F. Sternberg.

PLATE 2

Skull of *Palaecoscincus rugosidens*. Type. No. 11868, U.S.N.M. Superior view. About one-third natural size.

PLATE 3

FIG. 1.—Skull. Viewed from right side.

FIG. 2.—Right ramus of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M. Lateral view. About one-third natural size.

PLATE 4

FIG. 1.—Sacrum of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M. Ventral view. About one-fifth natural size.

FIG. 2.—Tooth of *Palaeoscincus asper* Lambe. Type. After Lambe.

FIG. 3.—Tooth of *Palaeoscincus costatus* Leidy. Type. Inner, end, and outer views. Three times natural size. After Leidy.

FIG. 4.—Tooth of *Palaeoscincus latus* Marsh. Type. *a*, natural size; *b*, twice natural size. After Marsh.

PLATE 5

Dermal bones of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M. All viewed from above.

FIG. 1.—Median pair of coössified dermal plates of the second nuchal row.

FIG. 2.—Lateral coössified plates (left side) of the second nuchal row.

FIG. 3.—Coössified dermal plates forming the left half of the first nuchal ring. All about one-fourth natural size.

PLATE 6

Dermal bones of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M.

FIG. 1.—Large spine that occupies a position lateral to the third transverse row of nuchal plates. Side view.

FIG. 2.—Dermal plate from side of the animal immediately posterior to the large spine shown in Figure 4. Top view.

FIG. 3.—Spine, from the end of the second transverse row of nuchal plates. Side view.

FIG. 4.—Large double-spined plate that projected outward from the side of the animal immediately above the fore leg. Lateral view. All figures about one-fifth natural size.

PLATE 7

Dermal plates and ilium of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M.

FIG. 1.—Thin ovate dermal scutes probably from above the sacral region. Superior view. About one-fourth natural size.

FIG. 2.—Median pair of nuchal plates of the second transverse row. Ventral view. Same as Figure 1, Plate 5. About one-fourth natural size.

FIG. 3.—Anterior end of right ilium, showing ends of three coössified dorsal ribs. Ventral view. About three and six-tenths natural size.

PLATE 8

Mounted skeleton of *Palaeoscincus* as exhibited in the American Museum of Natural History, New York, showing the dermal armor as it was found *in situ*.

FIG. 1.—Viewed from above. After Matthew.

FIG. 2.—The same viewed from the left side. Photograph by Amer. Mus. of Nat. History.

PLATE 9

Skull of *Dyoplosaurus acutosquameus* Parks. No. 11892, U.S.N.M.

FIG. 1.—Viewed from right side.

FIG. 2.—Viewed from above.

Both figures one-fourth natural size.

PLATE 10

FIG. 1.—Posterior part of frill of *Styracosaurus albertensis* Lambe. Type. Viewed from above. About one-twelfth natural size. After Lambe.

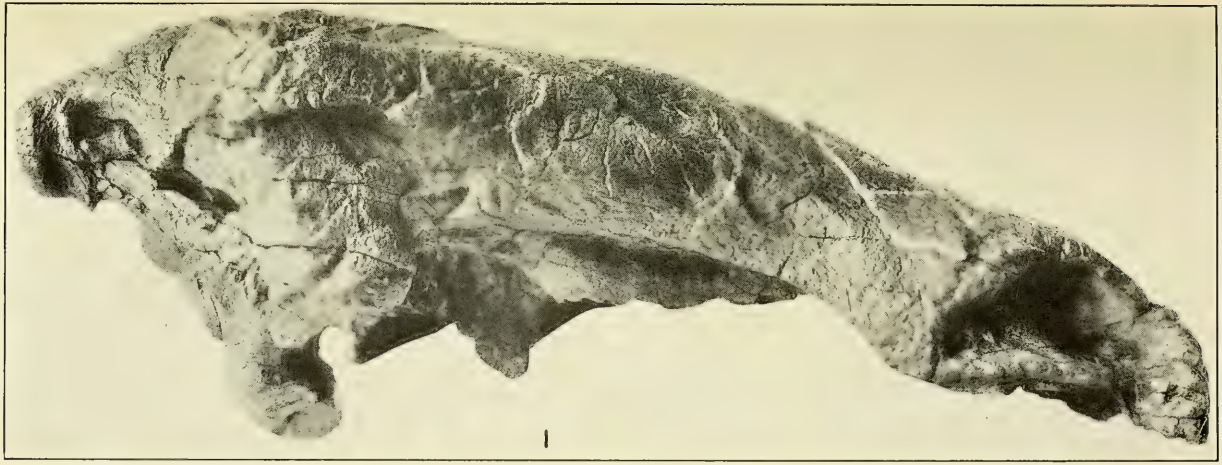
FIG. 2.—Posterior part of frill of *Styracosaurus ovatus*. Type. No. 11869, U.S.N.M. Viewed from above. About one-ninth natural size.

EXCAVATING SKELETON OF PALAEOSCINCUS RUGOSIDENS

FOR EXPLANATION OF PLATE SEE PAGE 38.

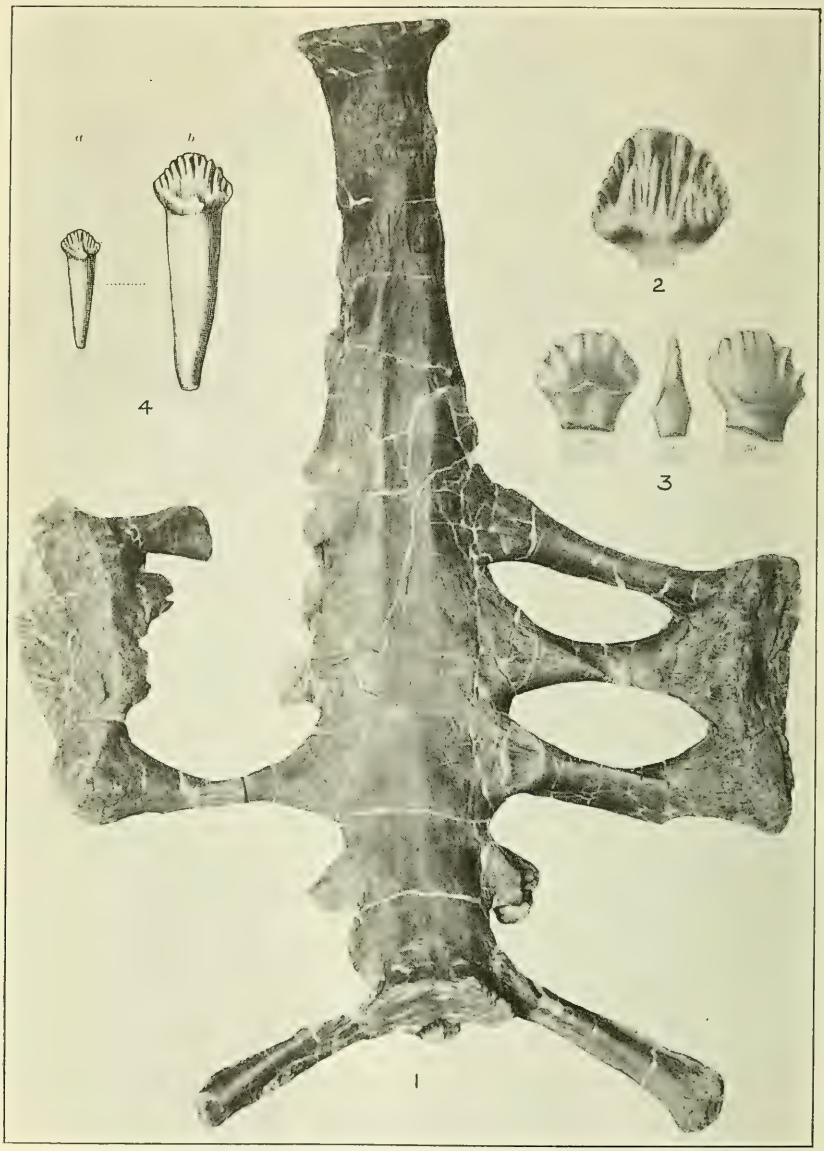
SKULL OF PALAEOSCINCUS RUGOSIDENS

FOR EXPLANATION OF PLATE SEE PAGE 38.



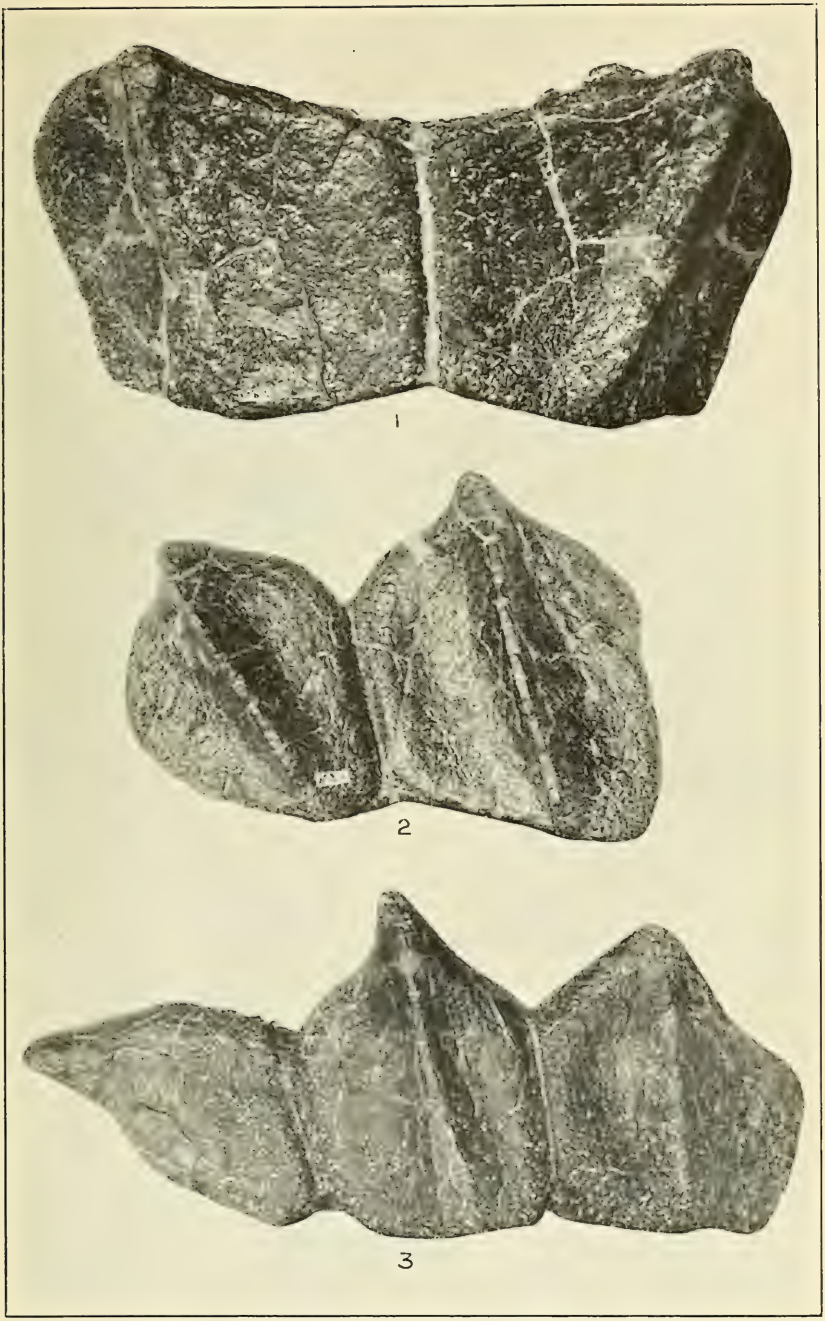
SKULL AND RAMUS OF PALAEOSCINCUS RUGOSIDENS

FOR EXPLANATION OF PLATE SEE PAGE 38.



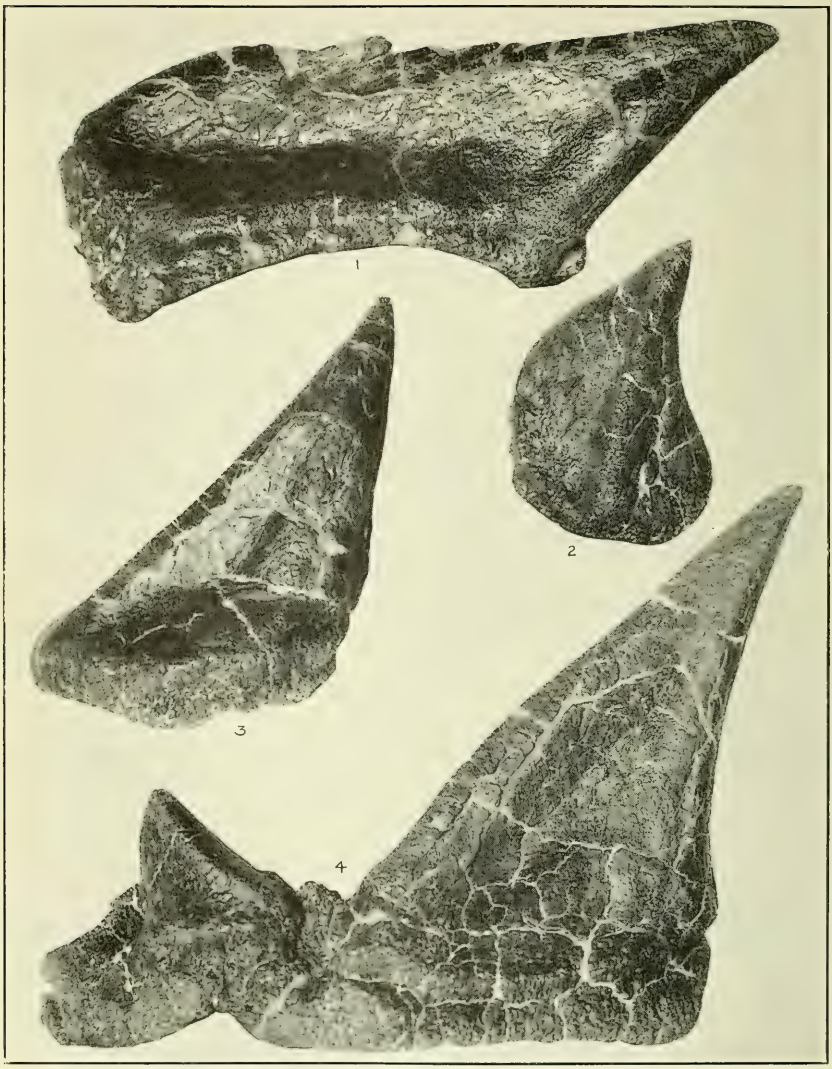
SACRUM AND TEETH OF PALAEOSCINCUS

FOR EXPLANATION OF PLATE SEE PAGE 38.



DERMAL SCUTES OF PALAEOSCINCUS RUGOSIDENS

FOR EXPLANATION OF PLATE SEE PAGE 38.



DERMAL SPINES OF PALAEOSCINCUS RUGOSIDENS

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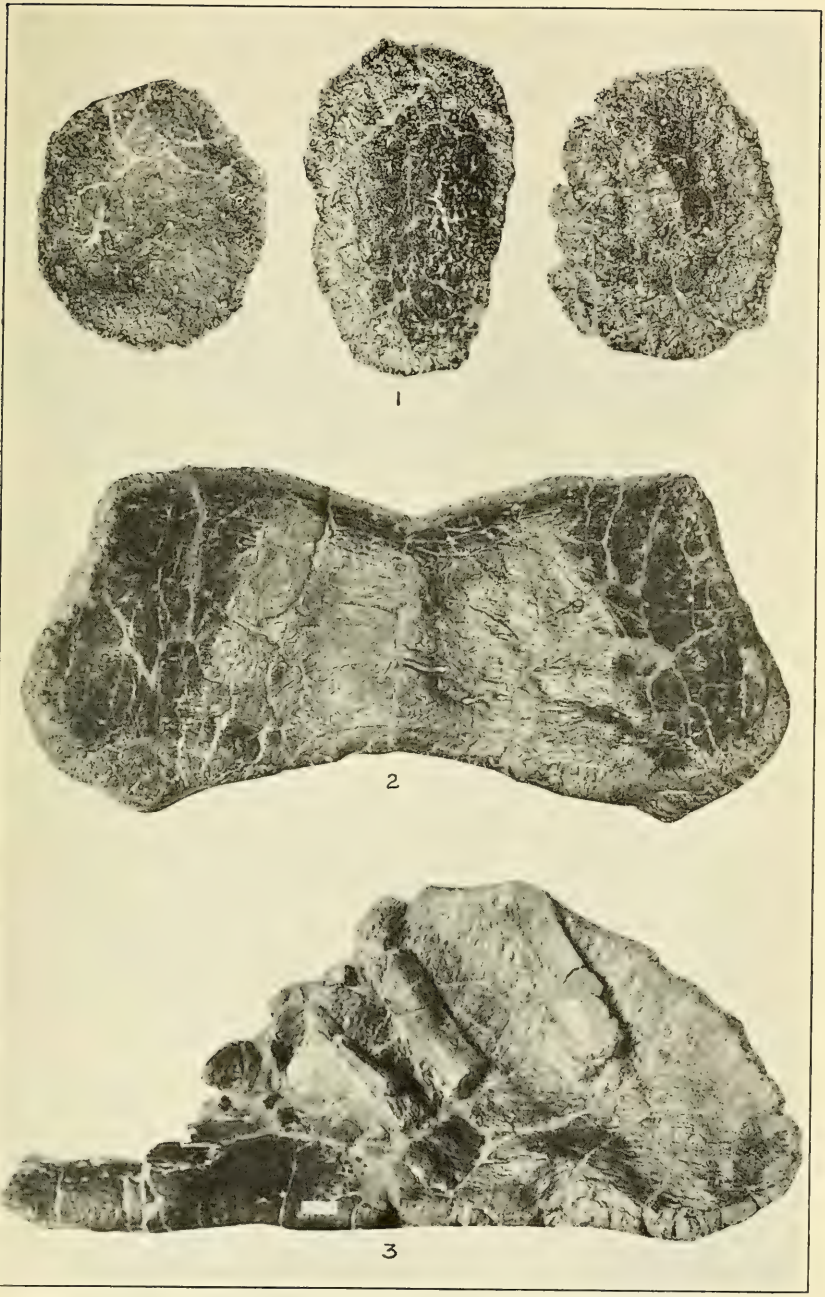

ILIUM AND DERMAL BONES OF PALAEOSCINCUS RUGOSIDENS

FOR EXPLANATION OF PLATE SEE PAGE 39.

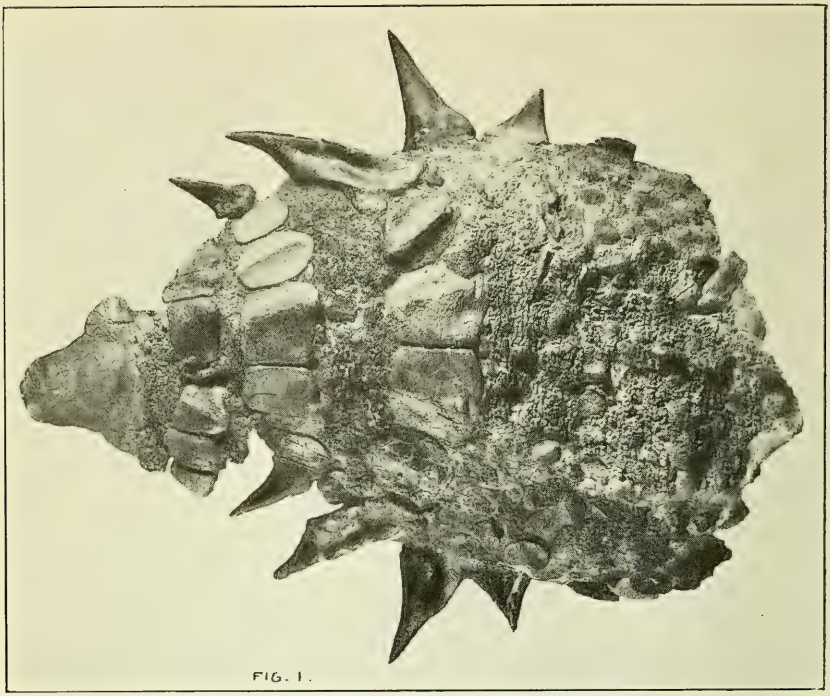

FIG. 1.

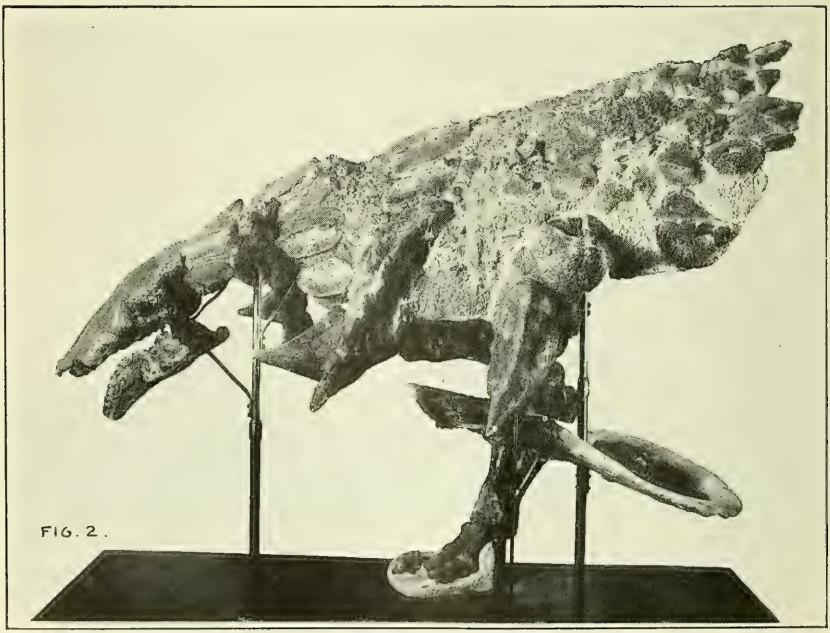

FIG. 2.

SKELETON OF PALAEOSCINCUS

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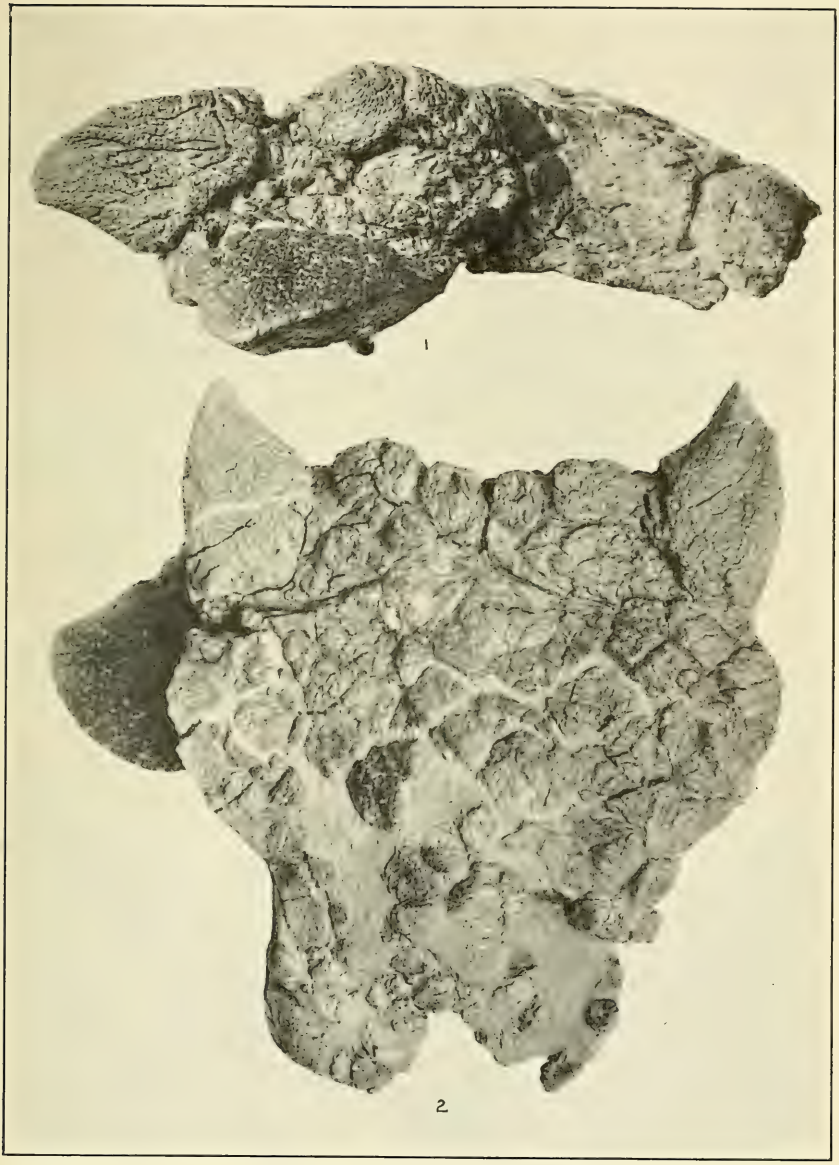

SKULL OF DYOPLOSAURUS

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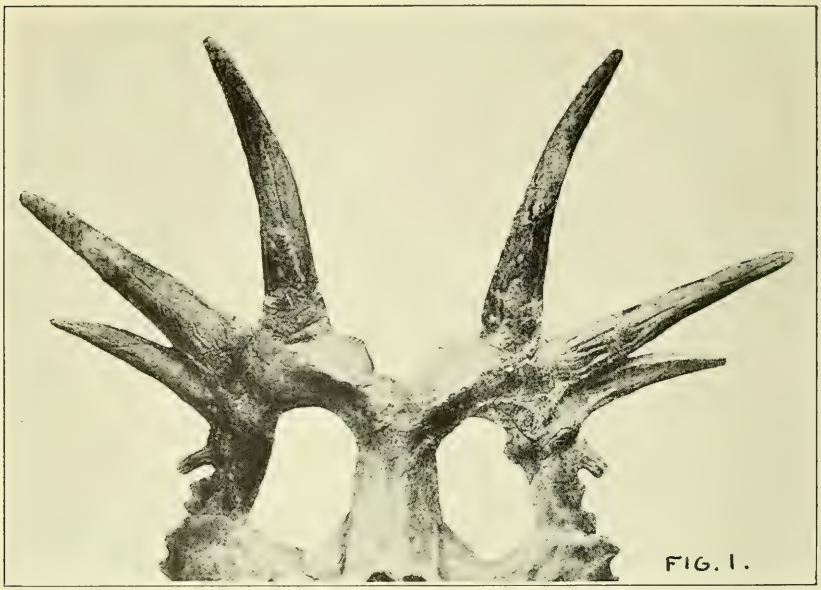

FIG. 1.

FIG. 2.

FRILLS OF STYRACOSAURUS

FOR EXPLANATION OF PLATE SEE PAGE 39.

STUDIES OF THE NORTH AMERICAN WEEVILS BELONGING TO THE SUPERFAMILY PLATYSTOMOIDEA

By W. Dwight Pierce

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The superfamily Platystomoidea Pierce (1916) is composed of those weevils classed by LeConte and Horn and other authors under the family Anthribidae. In planning a more comprehensive classification of the Rhynchophora it has been found best to raise the old conceptions of families to a superfamily rank.

The oldest valid name in the superfamily is *Platystomos* (Hellwig) Schneider (1791), and hence it gives its name to the family in which it is to be placed and also to the superfamily. The group is composed of individuals with clavate, nongeniculate antennae, flexible maxillary palpi, a distinct labrum, globose anterior coxae, and an exposed pygidium.

TABLE OF FAMILIES OF PLATYSTOMOIDEA

1. Prothorax with transverse carina near base; third joint of tarsus usually largely inclosed in the second ..... 2.
   Prothorax without transverse carina near base; third joint of tarsus free from second ..... Bruchelidae Pierce (1916) (not North American).
2. Antennae inserted on the sides of the rostrum; labial palpi three-jointed (Pleurocera) ..... Platystomidae Pierce (1916).
   Antennae inserted on the upper surface of the rostrum near the eyes; labial palpi at least sometimes four-jointed (Anocera).
   Choragidae Des Gozis (1882).

The transverse carina of the prothorax is of definite systematic value, as it represents the suture between two distinct portions of the thorax. This will be evident by examining the series of illustrations herewith presented. The area in front of this carina and laterally inclosed by it when the carina turns forward at the sides is the *scutellum.* From the anterior end of the lateral carina to the precoxae is often found the *pleural suture.* Its presence indicates a

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2602—30——1

primitive character in the weevils, and hence where possible the arrangement of groups has been altered to place those with a distinct pleural suture first.

The subfamilies and families are also arranged to show the backward and downward movement of the posttergite and postscutellum which are represented by the area behind the transverse carina. I shall call this carina the *scutellar carina*, as it often delineates three sides of the scutellum. The posterior declivity behind this carina often has another carina which may sometimes be basal. It separates the posttergite from the postscutellum and may be known as the *postscutellar carina.*

NOMENCLATURE OF GROUP

The group so long known as Anthribidae involves some difficult nomenclatorial problems.

After a thorough search of the literature I have found the following history applying to the nomenclature of the families:

Anthribus Geoffroy, 1762, Hist. Abr. des Ins., vol. 1, pp. 306–309.

Only one species satisfies the binomial requirement. Species No. 4 is definitely referred to Linnaeus, Fauna Suecica (first edition) No. 370, which is *Dermestes pulicarius.* This work is pre-Linnean (1746), but its second edition appeared in 1761, and furthermore the Systema Naturae, tenth edition (1758), also contains this species. In the twelfth edition (1767), p. 574, Linnaeus refers this species to *Silpha* and quotes *Anthribus* 4 Geoffroy as a synonym. Bradh (1769) cites *Anthribus* as equal to *Silpha.* The obvious conclusion is that *pulicarius* must become type of *Anthribus* and the genus must pass out of the Rhynchophora.

Hence *Anthribus* Geoffroy, 1762, with *pulicarius* Linnaeus as type, takes the place of *Brachypterolus* Grouvelle (1913), the subfamily Anthribinae takes the place of Cateretinae, and family Anthribidae of Nitidulidae.

The name *Anthribus* was subsequently given other meanings.

Anthribus Müller, 1764, Fauna Insectorum Friedrichsdalina, is not binomial.

Anthribus Forster, 1771 (Novae Spec. Insectorum, Centuria I). Forster follows Geoffroy, but adds two new species, *fasciatus* and *nebulosus*, neither of which can be made type of *Anthribus*, as they were not originally included. Equals *Brachytarsus* Schönherr (1833) not (1823).

Anthribus DeGeer, (Mem. Hist. Ins., vol. 5). This genus is monobasic, founded on *ruber* DeGeer, a synonym of *Silpha rustica.* It equals *Triplax* Herbst (1793).

Anthribus Müller, 1776 (Zool. Dan. Prodr., p. 57). Only a single species, *glaber*, is included. It does not belong to the Rhynchophora.

Anthribus Geoffroy, 1785 (Fourcroy's Ent. Paris, pp. 136–139), contains 12 species, of which *pulicarius* is fourth, and the only one available for type in his original genus of 1762.

Macrocephalus Olivier, 1789 (Intr. Hist. Nat. Ins., vol. 4, pt. 3, pp. 36, 158), includes only *Curculio albinus* Linnaeus, which becomes type, but the generic name is preoccupied by Macrocephalus Swederus 1787.

Anthribus Fabricius, 1790 (Nov. Ins. Gen., vol. 1). The genus is frequently dated from this description, based on four species, of which Latreille (1810) designated *latirostris* Fabricius as type. Inasmuch as the name *Anthribus* had been correctly used otherwise by Geoffroy (1762), Forster (1771), DeGeer (1775), Müller (1776), it is impossible to accept this interpretation, which is the one which led to the name Anthribidae as commonly used in America and Europe.

Platystomos (Hellwig) Schneider, 1791 (Nov. Ins. Gen., pp. 21–23). Schneider discusses Fabricius's name *Anthribus* (not Geoffroy, 1762) with four species and refers it to *Platystomos* (Hellwig). Following Bedel (1885) we may consider the first species, *albinus* Linnaeus, as type, and the genus takes the place of the preoccupied *Macrocephalus* Olivier (1789) and becomes the type genus for family and superfamily.

Family PLATYSTOMIDAE Pierce (1916)

This family is founded on *Platystomos* (Hellwig) (1791) and is equivalent to the group Pleurocera of Lacordaire.

TABLE OF SUBFAMILIES OF PLATYSTOMIDAE

Scutellar carina of prothorax prebasal	Platyrhininae, Everts (1903).
Scutellar carina basal	Platystominae, new subfamily.

Subfamily PLATYRHININAE Everts (1903)

This subfamily is founded on the genus *Platyrhinus* Clairville and Schellenberg (1798).

Following out the plan of classification, the groups of Lacordaire may be considered as hereby raised to tribal value, but a rearrangement of them will probably be necessary.

In the arrangement here proposed for the North American tribes an attempt is made to begin with the forms nearest approaching the Bruchoidea (Bruchidae) and close with the forms having the greatest modification of beak, thus approaching the Curculionoidea.

TABLE OF NORTH AMERICAN TRIBES OF PLATYRHININAE

1. Beak not or hardly longer than head ..... 2.
   Beak elongate; antennae of male longer than those of female ..... 4.
2. Scrobes dorsolateral, subterminal; antennae of male longer than those of female ..... Discotenini, new tribe.
   Scrobes lateral, foveiform, almost always covered by lateral margin of beak ..... 3.
3. Eyes emarginate; scrobes large, median, irregular ..... Phaenithonini, new tribe.
   Eyes entire ..... Platyrhinini Bedel (1882).
4. Eyes more or less approximate on the front ..... Eurymycterini, new tribe.
   Eyes lateral ..... 5.
5. Eyes rounded ..... Allandrini, new tribe.
   Eyes oblong-oval, longitudinal ..... Meconemini, new tribe.

DISCOTENINI, NEW TRIBE

Genus DISCOTENES Labram and Imhoff

Discotenes Labram and Imhoff, Singulorum generum Curculionidum, 1842, part 1.
Type, coelebs Labram and Imhoff, monotype.
Phanosolena Schaeffer, Journ. N. Y. Ent. Soc., 1904, vol. 12, p. 234.
Type, nigrotuberculata Schaeffer, monotype.

Two species are described for North America, and these may be separated by the following table:

TABLE OF NORTH AMERICAN SPECIES OF DISCOTENES

Eyes very close to antennal scrobes; body black beneath, ochraceous above, variegated with black patches on thorax and elytra. ..... nigrotuberculata Schaeffer.
Eyes distinctly separated from antennal scrobes; larger and darker, beak of male on each side above antennal fossae very convex, impressed on median line ..... arizonica Schaeffer.

DISCOTENES ARIZONICA Schaeffer

Phanosolena arizonica Schaeffer, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 269.

No specimens attributable to the species are found in the collections of the United States National Museum. It is recorded from the Huachuca Mountains, Arizona, August 10.

DISCOTENES NIGROTUBERCULATA Schaeffer

Phanosolena nigrotuberculata Schaeffer, Journ. N. Y. Ent. Soc., 1904, vol. 12, p. 235.

This species is described from Brownsville, Tex. The National Museum collection contains nine specimens from this locality, collected by C. H. T. Townsend, June 7, 1895; Hubbard and Schwarz, June 9; H. S. Barber, May 8, 1904; and Jones and Pratt, March 20, 1908 (six specimens).

A complete series of drawings of the characters of this species is given and will serve for comparison of these characters as we progress through the group.

The drawings of the upper (fig. 1), side (fig. 2), and under (fig. 3) views of the head are sufficient to present the essential characters of this tribe and genus, which is characterized by the shortness of the beak and the shape of the scrobes and eyes. Figures are also given of the thoracic sternal characters (fig. 4), the mouth parts (figs. 5, 6, 7), the differences of the antennae in the two sexes (fig. 8), the wing venation (fig. 9), the protarsus (fig. 10), the protarsal claw (fig. 11), the pygidium (fig. 12), and the female genitalia (fig. 13).

As the mouth parts of this family have not been carefully studied, considerable attention will be given to them in this paper.

The maxilla (fig. 6) is quite primitive in that it consists of an elongate cardo; a basal piece to stipes; the main portion of stipes strongly two lobed; the outer lobe or lacinia being provided with strong double series of bristles; and the long fingerlike inner lobe, or galea, which is narrowly but deeply cleft from the lacinia and with a brush of bristles at tip; the basal joint of the palpus small, the second very large and quadrate, the third small, and fourth elongate fingerlike. The last three palpal joints are dark brown, the remainder of the maxilla is transparent yellowish.

The mentum is a small segment to which the labium is attached (fig. 7). The labium is transverse, brownish, poorly defined, differing only from ligula in color. The ligula is yellow, shallowly bilobed. The palpi are attached on the diagonal sides of the labium, three jointed, light brown. The hypopharynx or inner side of labium and ligula is provided with a strong series of bristles in several rows on each side of the middle.

The wing venation (fig. 9) is in general characteristic of the Rhynchophora, but has its special characteristics. The costa is marginal and basal only. The subcosta is over twice as long and apically merged with the radius which from here to the node or transverse fold becomes submarginal. Behind the radius is the faint outline of the radial sector. Medius is a strong vein bracing the middle of the wing and at the transverse fold branches forward in a hooklike process and almost at right angles behind. The cubitus is a fine straight vein. At the transverse fold the radial vein is badly broken and a distinct but small triangular cell is formed. Two severed portions of radius appear in the apical half of the wing.

The pygidium (fig. 12) is distinctly furrowed for the reception of the elytral margin. The female genitalia (fig. 13) are provided at apex with four more or less blunt teeth. The male genitalia are elongate and slender.

The third tarsal joint is bilobed and not included in the second but is placed at its apex, a character found in the Bruchidae.

PHAENITHONINI, NEW TRIBE

TABLE OF GENERA OF NORTH AMERICAN PHAENITHONINI

1. Beak apically truncate, quadrate ..... 2.
   Beak obliquely rounded at apical angles ..... Griburiosoma Schaeffer.
2. Club small, solid, joints very indistinct (fig. 17) ..... Ormiscus Waterhouse.
   Club distinctly three jointed ..... Toxotropis LeConte.

Genus ORMISCUS Waterhouse

Ormiscus WATERHOUSE, Ann. Mag. Nat. Hist., 1845, vol. 16, p. 37. *Type.*—*variegatus* Waterhouse, monotype.

Hormiscus GEMMINGER and HAROLD, Cat. Col., 1872, vol. 9, p. 2738 (emendation).

TABLE OF NORTH AMERICAN SPECIES OF ORMISCUS

1. Scutellar carina angulate at middle ..... 2.
   Scutellar carina arcuate at middle (figs, 21, 22) ..... solidus, new species.
2. Scutellar carina more sharply and narrowly angulate (figs. 17–20). saltator LeConte.
   Scutellar carina broadly angulate (figs. 14–16) ..... angulatus, new species.

ORMISCUS ANGULATUS, new species

Described principally from a specimen collected at Dallas, Tex., April 15, 1908, by Hunter and Pratt.

Length, 2.1 mm.; breadth 1 mm. Color black with gray pubescence arranged in fasciae.

Head convex, beak transversely broadly impressed; head and thorax closely punctate and pubescent. Funicular joints of antennae longer than broad; diminishing in size to seventh which is about as broad as long. Club compact, slightly longer than last three funicular joints, three jointed. Eyes slightly emarginate. Pronotum convex, sharpely angulate at apices of scutellar carina, which is broadly angulate at center and does not extend forward on the sides. (Fig. 14.)

The pleural suture is represented by a distinct sinuate smooth line, as illustrated. (Fig. 15.) The centrosternal piece is distinct and triangular. (Fig. 16.) The pronotum is strongly and densely punctate and pubescent, the hairs being concolorous with the body except at the anterior corners and on each side of the scutellar carina. Elytra with two transverse bands of whitish pubescence, one dividing the elytra into three subequal brownish areas; the anterior band is connected with the base by sutural and humeral white areas. Scattered white areas on posterior declivity. The metasternum is medially impressed behind. The abdominal segments are strongly arched forward. The pygidium is grooved at base. Tarsal claws toothed.

Type.—Cat. No. 41357, U.S.N.M.

Specimens are at hand as follows: Texas (Belfrage collection labeled *Hormiscus saltator*); a paratype with same data as the type but measuring only 1.5 mm. in length; topotypes from Dallas collected May 16 and 18, 1907 (E. A. Schwarz), April 25, 1907 (Schwarz and Pratt), March 28, 1906 (W. E. Hinds); also a brownish specimen measuring 1.75 mm. from Victoria, Tex., April 1 (E. A. Schwarz) and a typical specimen from Nebraska City, Nebr., June. Some specimens have more whitish pubescence on the elytra than others.

ORMISCUS SALTATOR LeConte

Hormiscus saltator LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 397.

The characteristics of this species and genus are illustrated in Figures 17, 18, 19, 20.

This species is readily identified by the angle of the scutellar carina. The elytra have a distinct transverse white fascia near the base and only scattered white hairs behind.

This species was taken on dead branches of osage orange (*Toxylon pomiferum*) by Dury (Beutenmüller, 1893). It breeds in dead wood of deciduous trees (Smith, 1900; Ulke, 1902). The species occurs from New York to Florida and west to Nebraska and Texas. Two specimens were bred March 14, 1900, from galls of "*A. cornigera*" collected at Hartford, Conn. ["*A. cornigera*" doubtless refers to the Cynipid, *Andricus cornigera* Osten Sacken. (Ed.).]

ORMISCUS SOLIDUS, new species

This species is based on a specimen collected at Brownsville, Tex., by C. R. Jones and F. C. Pratt, March 20, 1908.

The eyes are not so emarginate as in *saltator*. The prothoracic carina (fig. 21) is sinuate or roundingly emarginate. The tarsal claws are cleft or toothed. Figure 22 illustrates the posterior tarsal claw.

Type.—Cat. No. 41358, U.S.N.M.

Genus TOXOTROPIS LeConte

Toxotropis LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, pp. 397–398. *Type*, *pusillus* LeConte, designated by Jordan (1906).

Gonops LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 399. *Type*, *fissunguis* LeConte, monotype.

TABLE OF NORTH AMERICAN SPECIES OF TOXOTROPIS

1. Claws simple; vestiture inconspicuous and very sparse—simplex, new species.
   Claws toothed ——— 2.
   Claws cleft almost to base; eyes strongly emarginate ——— fissunguis LeConte.
2. Elytra not tuberculate ——— 3.
   Elytra six tuberculate on the third intervals ——— 13.

3. Tarsal claws minutely and indistinctly toothed ..... 4.
   Tarsal claws distinctly provided with a more or less slender tooth ..... 6.
4. Prothoracic carina sinuate, broadly rounded at middle ..... 5.
   Prothoracic carina regularly but shallowly convex ..... sparsus, new species.
5. Prothoracic carina strongly arcuate; vestiture of elytra tessellate. pusillus LeConte.
   Prothoracic carina feebly arcuate; elytra with posterior half clad with darker vestiture ..... approximatus LeConte.
6. Antennae light yellowish or reddish throughout and very long and slender; elytra with a dark transverse fascia at about the middle. fasciatus LeConte.
   Antennae partly dark ..... 7.
7. Antennal funicle light reddish or brownish, club much darker ..... 8.
   Antennae dark throughout, except sometimes the basal joints ..... 11.
8. Prothoracic carina not very near to base at middle ..... 9.
   Prothoracic carina very near to base at middle ..... 10.
9. Femora light only at base; tibiae and tarsi light except at tips; elytra with a dark sutural spot at middle ..... quercus Schaeffer.
   Legs light except at tips of tibiae and tarsal joints, which are darker; elytra mottled ..... irroratus Schaeffer.
10. Legs reddish except at tips of tibiae and tarsal joints, which are darker; elytra with two dark basal and two dark median spots. quadrimaculatus, new species.
    Legs dark, reddish; elytra marmorate with a faint indication of two basal dark spots ..... eusphyroides Schaeffer.
11. Antennae black ..... 12.
    Antennae with first joint light; elytra darkening at base and with two dark lateral spots at middle ..... mitchelli, new species.
12. Elytra brown or black with a prominent white sub-basal fascia curved on each elytron to meet scutellum ..... albofasciatus Schaeffer.
    Elytra with two dark basal spots and two discal dark transverse fasciae. submetallicus Schaeffer.
13. Thoracic carina broadly rounded ..... sextuberculatus Schaeffer.
    Thoracic carina narrowly rounded ..... victoriensis, new species.

TOXOTROPIS SIMPLEX, new species

Described from a single specimen in the Hubbard and Schwarz collection from St. Catherine Island, Georgia, April 20.

Length, 2 mm. Dark reddish brown with gray pubescence. Beak flat, punctate, densely pubescent. Antennal joints longer than broad, diminishing in size, club distinctly three jointed. Eyes slightly emarginate. Prothoracic ridge very broadly arcuate behind, sinuate towards sides. Vestiture very fine, sparse and more or less irregular. Elytral strial punctures distinct. Tarsal claws divaricate, slender and simple.

Type.—Cat. No. 41359, U.S.N.M.

TOXOTROPIS PUSILLUS LeConte

Toxotropis pusillus LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 398.

Occurs at Key West, Florida, in April.

TOXOTROPIS APPROXIMATUS LeConte

Toxotropis approximatus LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 398.

Occurs in California. Has been beaten from dead twigs of live oaks (*Quercus*) in June (Fall, 1901*b*).

TOXOTROPIS SPARSUS, new species

Described from one specimen collected at Dallas, Tex., April 25, 1907 by E. A. Schwarz and F. C. Pratt.

Length, 1.5 mm. Dark brownish black with grayish pubescence. Beak flat, punctate, pubescent. Antennal joints slender, small and very little longer than wide, diminishing toward club. Club distinctly three jointed. Eyes emarginate. Prothoracic ridge regularly convex from side to side. Vestiture very fine and sparse, densest in basal area of elytra. Elytral strial punctuation distinct. Tarsal claws minutely toothed.

Type.—Cat. No. 41360, U.S.N.M.

TOXOTROPIS FASCIATUS LeConte

Toxotropis fasciatus LeConte, Trans. Amer. Ent. Soc., 1884, vol. 12, p. 32.

Very abundant in Texas and Louisiana from April to June, and also found in Maryland, New Jersey and New York.

TOXOTROPIS QUERCUS Schaeffer

Toxotropis quercus Schaeffer, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 270.

Occurs in the Huachuca and Chiricahua Mts., Arizona.

TOXOTROPIS IRRORATUS Schaeffer

Toxotropis irroratus Schaeffer, Journ. N. Y. Ent. Soc., 1904, vol. 12, p. 233.

Is common at Brownsville, Texas and nearby places from April to July.

TOXOTROPIS QUADRIMACULATUS, new species

Described principally from a specimen from Haw Creek, Florida, collected June 10, in the Hubbard and Schwarz collection.

Length, 2.75 mm. Light reddish brown, tessellated with dense brown and yellowish pubescence, with four large brown spots, two at the base of the elytra and two about the middle. Pubescence beneath sparser and uniform grayish. Beak flat, punctate, sparsely pubescent, apically shallowly emarginate. Antennae light brown, with club darker, joints elongate, slender; club elongate, distinctly jointed. Eyes sharply emarginate. Prothoracic ridge very strongly arcuate at middle and quite close to the base. Tarsal claws slender and with a long fine tooth.

Type.—Cat. No. 41361, U.S.N.M.

Material is also at hand from Crescent City, Fla., July 6, and Fort Monroe, Va., April 19 (Hubbard and Schwarz); Washington, D. C. (Linell); Jackson, Ala., April 19, 1910 (Pierce) (two specimens; Mobile and Oak Grove, Ala., June 15, 17 (Soltau); New Orleans, La., June 13 (Soltau) (two specimens); Tallulah, La., bred from fig wood May 3, 1910 (Cushman); Meridian, Miss., February 6, June 11, 1898 (Soltau) (three specimens).

TOXOTROPIS EUSPHYROIDES Schaeffer

Toxotropis eusphyroides SCHAEFFER, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 270.

Occurs at Brownsville, Tex., April to July.

TOXOTROPIS SUBMETALLICUS Schaeffer

Toxotropis submetallicus SCHAEFFER, Journ. N. Y. Ent. Soc., 1904, vol. 12, p. 234.

Occurs at various points in south Texas, March to August.

TOXOTROPIS ALBOFASCIATUS Schaeffer

Toxotropis albofasciatus SCHAEFFER, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 271.

Occurs at various points in south Texas, March to July. Taken on anacahuita (*Cordia boissieri*) May 30, 1910, at Gregory, Tex. (Pierce).

TOXOTROPIS MITCHELLI, new species

Described from 41 specimens bred from stems of *Xanthium* by J. D. Mitchell at Victoria, Tex., in March, April, and May, 1908.

Length, 2 mm. Brown, clad with dark and pale scales to form a more or less definite pattern, marked principally by two dark basal spots on the elytra and two dark lateral spots at the middle of the elytra. Legs, especially at the basal portions of the tibiae, lighter and more yellowish brown; tarsi black. Antennae dark, with basal joints lighter. Beak flat, pubescent, punctate. Eyes rather deeply emarginate. Antennal funicle slender, joints elongate, becoming shorter toward club which is rather elongate. Prothoracic ridge strongly arcuate at middle. Tarsal claws with a long slender tooth.

Type.—Cat. No. 41362, U.S.N.M.

The species has also been collected on *Xanthium* at Victoria, Tex., April 15, 16 by J. D. Mitchell; bred from *Solanum rostratum* stems at Victoria in March and April (Mitchell); bred from *Ambrosia trifida* and *A. psilostachya* stems at Victoria from February to April (Mitchell, Hinds); bred from *Iva ciliata* stems at Victoria in

February (Mitchell); bred from *Helianthus* stems at Victoria in April (Mitchell); collected on *Acuan illinoensis* at Victoria in June (Cushman); collected at Corpus Christi (Schwarz) and Brownsville (Schwarz, Jones, and Pratt). In Louisiana it was bred in October from pods of *Datura stramonium* collected at Ferriday in August.

TOXOTROPIS VICTORIENSIS, new species

Described from three specimens collected by E. A. Schwarz at Victoria, Tex., March 21, April 3, and 5.

Length, 2.2 to 2.6 mm. Very dark blackish brown, with dark brown, black, white, and golden pubescence, and with six elytral tubercles. Legs reddish. The white pubescence occurs in a patch on the median line of the prothorax near the apex and another near the base, on the scutellum, mixed with the golden beneath and scattered inconspicuously above. The golden pubescence occurs all over the body, but most conspicuously on the head and beak and underneath. The black pubescence is suberect on the six tubercles and occurs also in little scattered spots. The brown is generally mixed with the other colors. Beak flat, pubescent, punctate, apex sinuate. Antennal funicle with joints elongate, club long. Eyes emarginate. Third elytral interval trituberculate. Tarsal claws armed with a very long slender tooth.

Type.—Cat. No. 41363, U.S.N.M.

TOXOTROPIS FISSUNGUIS LeConte

Gonops fissunguis LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 398.

Occurs in California.

TOXOTROPIS SEXTUBERCULATUS Schaeffer

Toxotropis sextuberculatus Schaeffer, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 269.

Occurs at Enterprise and Lake Worth, Florida.

Genus GRIBURIOSOMA Schaeffer

Griburiosoma Schaeffer, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 272.
Type, platanum Schaeffer, monotype.

This genus may possibly have to be combined with *Ormiscus*.

GRIBURIOSOMA PLATANUM Schaeffer

Griburiosoma platanum Schaeffer, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 273.

This species was taken from dead branches of sycamore (*Platanus* sp.) in the Huachuca Mountains, Ariz. (Schaeffer, 1906).

TRIBE PLATYRHININI BEDEL (1882)

Tropiderini KLEINE, Entomologischen Blättern, 1910.

Only one genus occurs in North America. The weevils of this tribe breed under the bark of dying branches and trunks of trees.

TABLE OF GENERA[1]

Transverse ridge of prothorax converging to base at middle; sides of prothorax behind middle strongly widened; eyes broadly separated, small, prominent; antennae short, with an apparently loosely jointed club.
Platyrhinus Clairville.

Transverse carina parallel with the base; sides of prothorax straight, sometimes slightly widened; eyes large, depressed, more or less approximate beneath.
Tropideres Schönherr.

Genus PLATYRHINUS Clairville

Platyrhinus CLAIRVILLE, Entomologie Helvetique, 1798, vol. 1, p. 112. *Type*, (*costirostris* Clairville) designated by Latreille, 1810=(*latirostris* Fabricius)=*resinosus* Scopoli (Ent. Carn., p. 24).

Anthribus FABRICIUS, Nova Insectorum Genera, 1790, p. 213 (not Geoffroy, 1762, Forster, 1771, DeGeer, 1775, Müller, 1776, Forster, 1781, Geoffroy, 1785).

Platyrrhinus GEMMINGER and HAROLD, Cat. Col., 1872, vol. 9, p. 2732. (Emendation.)

Platyrhinus resinosus Scopoli (*latirostris* Fabricius) inhabits fungi growing upon ash trees in England. It has also been found in *Sphaeria fraxinea* (Westwood 1839), on decaying oak stump highly charged with mycelia of a fungus (Rivers, 1886). The larvae breed under the bark of decaying twigs of *Carpinus betulus* Linneaus, *Fraxinus excelsior* Linneaus, *Betula alba* Linneaus, *Alnus glutinosa* Gaertner, *Fagus silvatica* Linneaus, and *Ulmus* spp., (Kleine, 1910, E. B. 45). Breeds also in dead wood of *Quercus* (Schaufuss 1914, 1026.)

Genus TROPIDERES Schönherr

Tropideres SCHÖNHERR, Isis von Oken, 1823, Heft 10, p. 1135. *Type, albirostris* Fabricius.

Tropideres SCHÖNHERR, Curc. Disp. Meth., 1826, p. 35. *Type, albirostris* (Herbst), Fabricius by original designation.

Enedreytes SCHÖNHERR, Gen. et sp. Curc., 1839, vol. 5, p. 215. *Type, hilaris* Fahraeus.

Enedreutes LACORDAIRE, Gen. Col., 1866, vol. 7, p. 536.

Tropidoderes GEMMINGER and HAROLD, Cat. Col., 1872, p. 2733.

The above synonymy is according to Bovie. He writes that this genus does not occur in North America, although he quotes *bimaculatus* Olivier in the genus. I can find no essential reason for not including the following species in this genus. The eyes are entire in all of them. The species all breed under the bark of decaying wood.

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[1] After Schaufuss, Calwer's Käferbuch, 1916, p. 1026.

TABLE OF NORTH AMERICAN SPECIES OF TROPIDERES

1. Body elongate, prothorax set off from elytra by the constriction behind the prothoracic ridge. Epistoma apically bidentate----------2.
   Body compact; prothorax set close to elytra, constriction behind ridge not so strong. Epistoma apically emarginate, not dentate----rectus LeConte.
2. Sides of prothorax strongly sinuate, due to prominence of lateral prolongations of prothoracic ridge----------bimaculatus Olivier.
   Sides of prothorax almost evenly rounded----------barberi, new species.

TROPIDERES BIMACULATUS Olivier

Macrocephalus bimaculatus OLIVIER, Entomologie, 1795, vol. 4, no. 80, p. 14, pl. 2, fig. 11.
Anthribus quadrinotatus SAY, Journ. Acad. Nat. Sci. Phila., 1827, vol. 2, p. 249.

Material is at hand from Staten Island, N. Y. (H. Soltau); Washington, D. C., July 13 (Hubbard and Schwarz); Afton, Va. (Hubbard and Schwarz); Memphis, Tenn., September 5 (H. Soltau); Cincinnati, Ohio, June 24, 29 (H. Soltau); St. Louis, Mo., March 17 (H. Soltau); Tallulah, La., March 5, 1910 (R. A. Cushman); Bayou Sara, La., January 24, 1879 (Hubbard and Schwarz); Meridian, Miss., February 10, 11, 1879 (E. A. Schwarz). It is found on dead twigs.

The accompanying sketches illustrate the face (fig. 23), under side of head and mouth parts (fig. 24), side of head (fig. 25), protarsal claw (fig. 26), metatarsal claw (fig. 27).

The mesotarsal claw is toothed, and the metatarsal claw slightly appendiculate in one view.

TROPIDERES BARBERI, new species

Length, 3–3.5 mm. Similar to *T. bimaculatus* in general markings and appearance but differing by having the punctuation of the head and thorax much finer, and the sides of the prothorax evenly convex. The angles of the apical emargination of the beak are never acute, dentiform as in *bimaculatus*. The elytral tuberculation is almost obsolete.

Described from eight specimens collected at Esperanza Ranch and at Los Borregos, near Brownsville, Tex., May 18 to June 6, 1904, by H. S. Barber.

Type and Paratypes.—Cat. No. 41364, U.S.N.M.

Figure 28 illustrates the protarsus, and shows the partially concealed third joint typical of Platystomidae and Choragidae.

TROPIDERES RECTUS LeConte

Tropideres rectus LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, pp. 395–396.

Material is at hand from Washington, D. C., July 30 (Hubbard and Schwarz); Savannah, Ga. (Hubbard and Schwarz); Biscayne,

Fla., April 29–May 13 (Hubbard and Schwarz, M. Linell); Key West, Fla., April (Hubbard and Schwarz); Meridian, Miss., June 11, 1898 (H. Soltau); Columbus, Tex., May 30–June 3 (Hubbard and Schwarz).

This species also is taken on dead twigs and branches (Schwarz, 1878; Ulke, 1902). It occurs from Florida northward to the District of Columbia and westward to Texas.

The following notes on European species throw light on the habits of the genus.

Tropideres albirostris Herbst of Europe breeds in dead wood of beech (*Fagus* sp.), oak (*Quercus* spp.) and poplar (*Populus* spp.) (Bedel, 1885). On dead trees of *Tilia*, *Fagus*, *Alnus*, *Betula*, *Quercus*, *Salix*, *Prunus cerasus*, *Prunus communis*, *Rhus*, *Populus*, May to July (Schaufuss, 1914, p. 1027). Breeds in dead twigs of *Betula alba* Linneaus, *Tilia grandiflora* Ehrh., *Tilia parvifolia* Ehrhart, *Fagus silvatica* Linneaus and *Alnus glutinosa* Gaertner (Kleine, 1910, 46).

Tropideres dorsalis Thunberg of Europe is found on dry branches of *Quercus* and *Betula* in May (Schaufuss 1914, p. 1027).

Tropideres marchicus Herbst of Europe breeds in dead wood of fruit trees, especially peach (*Amygdalis persica*), also on young elm (*Ulmus* sp.) (Bedel 1885). Breeds under the bark of dead twigs of *Prunus domestica*, *Quercus*, *Salix*, and *Populus* (Kleine 1910). On dry twigs of *Salix*, *Populus*, *Quercus*, *Prunus*, and *Amygdalis* (peach), the larvae being found under the bark (Schaufuss, 1914, p. 1027).

Tropideres niveirostris Fabricius of Europe breeds in dead branches, fagots, and hedges of oak (*Quercus* spp.), hazelnut (*Corylus* spp.), beech (*Fagus* sp.) and linden (*Tilia* sp.) (Bedel 1885). On dead trees and dry branches of *Salix*, *Quercus*, *Tilia* and *Corylus* (Schaufuss, 1914, 1027). Breeds in dead branches of *Fagus silvatica* and *Salix capraea* (Kleine, 1910).

Tropideres pudens Gyllenhal of Europe breeds in dead branches of oak (*Quercus* sp.) (Bedel, 1885).

Tropideres sepicola Fabricius of Europe breeds in dead branches of oak (*Quercus* sp.) and *Carpinus* sp. (Bedel, 1885).

Tropideres undulatus Panzer of Europe breeds in dead branches of fruit trees (Bedel, 1885). In dead branches of *Quercus* (*Schaufuss*, 1914, p. 1027).

Tropideres hilaris Fahraeus of Europe breeds in the base of Scotch broom (*Cytisus scoparius* Link). The female oviposits in the root crown (Bedel, 1885).

Tropideres oxyacanthae Ch. Brisout of Europe breeds in the trunks of small dead beech (*Fagus* sp.), sometimes in numbers; in

dead wood of hawthorn (*Crataegus* sp.), and chestnut (*Castanea* sp.). The larva makes its gallery in the sapwood (Bedel, 1885). Also in dry twigs of *Carpinus* (Schaufuss, 1914, 1027).

EURYMYCTERINI, NEW TRIBE

This tribe is founded on two American genera, *Eurymycter* LeConte and *Gonotropis* LeConte; with large eyes; flattened beak, narrower at base than head and enlarged apically; lateral foveiform scrobes covered by the lateral margin of the beak; and different sized antennae in the two sexes.

TABLE OF GENERA

Prothoracic ridge strongly angulated and approaching the base at the middle; claws minutely toothed ..... Gonotropis LeConte.
Prothoracic ridge straight at the middle, base deeply biemarginate; claws acutely toothed ..... Eurymycter LeConte.

Genus GONOTROPIS LeConte

Gonotropis LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, pp. 393–394. *Type*, *gibbosus* LeConte, monotype.
Only one species occurs in the United States.

GONOTROPIS GIBBOSUS LeConte

Gonotropis gibbosus LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 394.

Occurs in Colorado. It is represented in the United States National Museum from Marquette, Michigan, June 26–July 29 (Hubbard and Schwartz) and Dundee, New York, June 13 (Hubbard and Schwarz).

This species has been described as having simple claws but the accompanying sketch (fig. 36) shows that there is a minute tooth.

The face is figured in figure 29, side of head in figure 30, underside of head in figure 31, inner view of maxillae in figure 32.

The prothorax (figs. 33 and 34) shows more primitive characters than *Allandrus* or *Meconemus* as well as *Eurymycter* in that practically all of the principal thoracic areas are more or less delineated. The anterior margin has a narrow strip which includes the postocular lobes and corresponds to the pretergite. On the venter viewed from the side there is a constriction near the apex which may be said to limit the presternite. This line is faintly indicated to the dorsum and indicates the praescutal area above. The well-known prebasal ridge is the limiting line for the base and sides of scutellum. The scutem and scutellum are faintly separable by a transverse elevation extending toward the terminus of the lateral ridge. From this point on to the lateral ridge the only definite suture of the pro-

thorax extends downward almost to the coxa and then is flexed backward to the posterior corner of the coxal cavity. This is the pleural suture. (Fig. 34). In front of it is the episternum and behind it the epimeron. The lateral ridge extends faintly forward from the pleural suture and connects with a very faint transverse line which separates the episternum from the basisternite. The basisternite (Fig. 35) between the coxae is acutely terminated. Its apex just barely separates the coxae and meets the acute apex of the so-called intercoxal piece. This piece is often triangular, but in the present genus it is fused with the epimera. The posterior slope of the dorsum behind the prebasal ridge is divided transversely by a lesser ridge on the declivity, which laterally turns forward and meets the other ridge, thus definitely defining the posttergite. The area behind this is continuous with the epimeron and is probably the postscutellum.

Genus EURYMYCTER LeConte

Eurymycter LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, pp. 394, 395. *Type*, *fasciatus* Olivier, monotype.

This genus has for a long time been considered to contain but one species. A careful study of the series in the United States National Museum has, however, revealed several species which are differentiated by the following table. All have the prominent white band across the posterior half of the elytra, and the face white.

TABLE OF SPECIES OF EURYMYCTER

1. Profile of front between eyes almost level, ocular ridge indistinct; underside of abdomen clothed with white ..... 2.
   Profile of front between eyes concave, ocular ridges strongly elevated; underside of abdomen not densely clothed with white ..... 4.
2. Elytra with one elevated interval, the third; fascia very broad and more regular in outline than in the following species; beak lightly tricarinate; thoracic carina arched forward ..... latifascia, new species.
   Elytra with alternate intervals elevated or more densely pubescent in crossing the transverse fascia, which is irregular in outline, thoracic carina almost straight ..... 3.
3. Beak strongly bicarinate ..... bicarinatus, new species.
   Beak less strongly carinate, the two lateral carinae farther apart than in *bicarinatus* and with a third or median carina in the basal portion of the beak ..... fasciatus Olivier.
4. Elytra more strikingly tuberculate, alternate intervals elevated, beak distinctly tricarinate; thoracic carina angulate or curved backward. tricarinatus, new species.

A character is evident in this genus which has not been observed in the preceding genera, that is the trace of a deep suture beneath the eye. This is of variable length in the genus. It is a little dif-

ficult to know how far species differentiation should go in this genus. The author has tried to be conservative in dealing with this genus which shows so many diverging characters.

EURYMYCTER LATIFASCIA, new species

Described principally from a specimen from Buffalo, N. Y., in the Hubbard and Schwarz collection.

Length, 7 mm., breadth, 3.2 mm. This species hitherto confused with *fasciatus* Olivier differs in a number of respects. In *fasciatus* the thoracic carina is almost straight at the middle, and laterally forms a tubercle at its basal angle and also at its apex. In the new species the carina is slightly arcuate anteriorly at the middle, and laterally curves concavely from a not prominent basal angle to an acute tubercle at its apex. The median line of the beak is less distinct than in *tricarinatus*. The elytra are smoother and only the third interval is distinctly elevated in *latifascia*, while in *fasciatus*, etc., the third, fifth and seventh are elevated. The outlines of the fascia in *fasciatus* are very irregular and angulate, and the fascia is narrower than in *latifascia*, which has the outlines of this band much more even.

A second specimen measuring 5 mm. is at hand from Ontario.

Type and paratype.—Cat. No. 41365, U.S.N.M.

EURYMYCTER BICARINATUS, new species

Described from a single specimen from Tenino, Washington in the Hubbard and Schwarz collection.

Length, 8.5 mm., breadth, 4 mm. This species hitherto confused with *fasciatus* Olivier differs in several respects. The rostral carinae are close together and very prominent, with no room for a median carina between them as in *fasciatus;* the elytral fascia is broader, the strial punctures are irregular in length, many quite elongate; the thoracic carina is even straighter than in *fasciatus;* the thoracic sculpture is coarser and deeper.

Type.—Cat. No. 41366, U.S.N.M.

EURYMYCTER FASCIATUS Olivier

Macrocephalus fasciatus OLIVIER, Entomologie, 1795, vol. 4, No. 80, p. 9, pl. 1, fig. 9.

The specimen at hand which most nearly answers the description of this species, originally described from Georgia, is from Crescent City, Fla., in the Hubbard and Schwarz collection, labeled January 12. This has an almost straight basal thoracic carina; two

distinct rostral carinae with a less distinct median basal carina; indistinct ocular carinae; narrow, irregular white fascia; abdomen white beneath; alternate elytral intervals slightly elevated, more densely pubescent on the fascia; dorsal profile very slightly sinuate.

Length, 8 mm., breadth 3.25 mm. Figure 37 illustrates the face, Figure 38 dorsum of head, Figure 39 the dorsum of thorax, and Figure 40 side of thorax and elytron.

Further material associated under this species is from South Carolina, (Riley); Meridian, Miss., June 11, 1898, (H. Soltau); Victoria, Tex., April 16, 1911, (J. D. Mitchell), on *Xanthoxylum clava-herculis;* East Tennessee, (Dr. Fox); Bladensburg, Md., July 7, (Hubbard and Schwarz); Staten Island, N. Y., (M. L. Linell); Detroit, Mich., (Hubbard and Schwarz) and Marquette, Mich., July 8, (Hubbard and Schwarz.)

The smallest specimen, the one from Tennessee, measures 6.5 mm. by 2.7 mm.

EURYMYCTER TRICARINATUS, new species

Described principally from a specimen from Branchtown, Pa., collected by W. J. Roberts.

Length, 7 mm., breadth, 3.1. Rostrum distinctly tricarinate; ocular carinae strong; prothoracic carina angulate or posteriorly curved backward; elytral fascia narrow, irregular; alternate elytral intervals elevated, more densely pubescent, with white beneath; abdomen not thickly clad, dorsal profile strongly sinuate.

Type and nineteen paratypes.—Cat. No. 41367, U.S.N.M.

Further material is at hand from Stone Creek, Lee County, Va. (Hubbard and Schwarz) four specimens; Retreat, N. C., June 2 (Hubbard and Schwarz); Washington, D. C., June 1 (Hubbard and Schwerz); Milwaukee, Wis., July 7, 1893 (H. Soltau) two specimens; Cincinnati, Ohio, August 22, June 29 (H. Soltau) eight specimens; Kentucky, Ind., two specimens.

Figure 41 illustrates the top of head, Figure 42 the underside of head, Figure 43 the right metatarsus, and Figure 44 the right metatarsal claws.

ALLANDRINI, NEW TRIBE

This is founded on a single genus, *Allandrus* LeConte. It is distinguished from the Eurymycterini by the lateral eyes.

Genus ALLANDRUS LeConte

Allandrus LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 396. *Type, bifasciatus* LeConte, monotype.

TABLE OF SPECIES OF ALLANDRUS [2]

Claws strongly divergent, antennae and legs black; male beak flat with smooth median line, female beak usually without line_____populi, new species.
Claws more approximate, toothed; antennae and legs tinged with rufous; male beak with median line crested; female beak with slightly raised median line_____bifasciatus LeConte.

ALLANDRUS POPULI, new species

Length of male, 3.5 mm.; of female, 2.75–4 mm.

Black throughout, with fine white pubescence sparse on head and prothorax, arranged in fasciae on the elytra and regularly but not closely placed on under sides. Elytral fasciae consisting of an irregular transverse band at basal third, which extends forward on the median line to the prothoracic ridge. Behind the middle the white spots are rather irregular but occupy the greater part of the apical third. The pygidium is also clad with white pubescence. The darker areas are provided with inconspicuous fine black pubescence. Claws (fig. 47) slender, strongly divergent, slightly enlarged or appendiculate near the base.

The beak (fig. 45) of the male has a fine median line which is not in the least crested as in *bifasciatus*. In the female there is not a trace of this line. The male antennae reach to the posterior third of the elytra. The female antennae barely pass the elytral humeri.

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[2] After this treatment was written a species was described as *Allandrus brevicornis* Frost 1920 (Can. Ent., vol. 52, p. 252), the introduction of which into Pierce's key necessitates changes in the copy submitted; and because of the author's absence the undersigned undertook reexamination of the material to guide the editorial changes. Through the kindness of Mr. C. A. Frost, cotypes of *brevicornis* were examined in connection with the Allandri which were before Pierce, as well as other specimens now available—some 82 specimens in all. Three species are now recognizable in this material and the following table and notes may help in their identification:

1. Male with median carina of rostrum strongly developed into a prominent lamella and with front tibiae very strongly curved in middle half, the apical fourth broader and straight. Tarsal claws rather stout, small and with well developed tooth. Canada, Virginia, Iowa_____bifasciatus LeConte.
   Male with rostrum not, or very feebly, carinate and with front tibiae simple. Tarsal claws more slender and with, or without, a tooth near middle_____2.
2. Claws with acute tooth near middle. Maine to California_____brevicornis Frost.
   Claws without trace of tooth near middle but with inner edge feebly enlarged and sometimes subangulate close to base. Arizona, Idaho, Michigan_____populi Pierce.

A. bifasciatus LeConte. Four specimens in the Green collection are labeled "Bred on Linden by A. B. Champlain, Harrisburg, Pa., 1921," and one is from northern Illinois. Other localities represented are Iowa City, Iowa, Sept. 3, 1917 (Buchanan); Prince Edward County, Ontario, April 15, 1915 (Brimley); Canada; and Wisconsin. Of the nine males examined, two have the secondary sexual characters less developed.

A. brevicornis Frost was described from a series of about 14 cotypes, several of which were distributed. Three localities (Edmonton, Alberta; Framingham, Mass.; and Monmouth, Me.) were recorded without designation of holotype or a type locality; and as the first-mentioned locality is represented before me by two kinds of tarsal claws (representing distinct species), the undersigned here designates as lectotype the male of a pair of cotypes mounted on one pin and loaned from the Frost collection, the pin label reading "C. A. Frost, Framingham, VII–18–15, Mass." Two of the seven cotypes now assembled bear locality labels other than those originally mentioned. One of these, from Natick, Mass., "VII–27–'12," is in the Casey collection, and the other, from Sherborn, Mass., was among the five cotypes loaned by Mr. Frost, who had previously deposited a Framingham cotype in the National collection. He now writes that the type locality, about a half mile in

Described principally from one male (type) and eight females taken in bark of *Populus tremuloides* at Williams, Ariz., June 4 to 11, by E. A. Schwarz and H. S. Barber.

Specimens are at hand from Beaver Canon, Idaho, July 23; Park City, Utah, June 18, and Marquette, Mich., July 26 (all in the Hubbard and Schwarz collection).

Figure 46 illustrates the dorsum of the prothorax.

Type and twenty-seven paratypes.—Cat. No. 41402, U.S.N.M.

ALLANDRUS BIFASCIATUS LeConte

Allandrus bifasciatus LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 396.

Described from Canada. Specimens are at hand from Ontario; Buffalo, N. Y. (H. Soltau); Marquette, Mich., July 30 (Hubbard and Schwarz); Penington Gap, Va., July 8 (Hubbard and Schwarz); Cincinnati, Ohio, August 11 (H. Soltau).

Figure 48 illustrates the under side of the head and Figure 49 the female metatarsal claws.

MECONEMINI, NEW TRIBE

This tribe is founded on the genus *Meconemus* Labram and Imhoff.

Genus MECONEMUS Labram and Imhoff

Ischnocerus Schönherr, Gen. et Sp. Curc., 1839, vol. 5, p. 192. *Type, infuscatus* Fahraeus (not *Ischnocerus* Gravenhorst 1829).

Meconemus Labram and Imhoff, Singulorum Generum Curculionidum, 1842, vol. 1, No. 40. *Type* (*tuberculatus* Labram and Imhoff) = *infuscatus* Fahraeus.

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extent, covers the intersection of the three townships, but that the old willow trees from which they were taken are now nearly all gone. Two other specimens in the Casey collection were undetermined, one being from the type locality and the other from the Casey farm, Boston Neck, North Kingston, R. I., July 14, 1888. From these nine New England specimens I can not satisfactorily distinguish four of the five specimens from Edmonton, Alberta (the other is referred to *populi*), assembled from the Casey, Buchanan, and Frost collections, or the five specimens from Banff Springs, Alberta; Sisson, Calif.; Bear Paw Mountain, Mont.; and Marquette, Mich. (female and male); in the Hubbard and Schwarz collections, to which varietal rank and a new name had been given in the Pierce manuscript. Another specimen from Garland, Colo. (Schwarz), standing in the Casey collection as *bifasciatus*, is also referred here.

A. populi Pierce. The type set was found on, or in pupal cells in, the bark of quaking aspen in 1901, at which time Mr. Schwarz told of finding the same species on the same host tree in other localities. The 28 specimens which were before Pierce are now further supported by nine more in the Casey collection, adding the localities New Mexico and southwestern Utah (Weidt); and one from the Greene collection, representing Colorado, as well as by a specimen in the Frost collection, labeled "Edmonton, Alta., VII. 16, 1920, F. S. Carr."

It is noteworthy that *brevicornis* and *populi* are represented from two localities. From Marquette, Mich., July 26, 1877, are preserved two specimens, male and female, of *brevicornis* and seven of *populi* (these having been recorded as *Allandrus bifasciatus* LeConte in the "Michigan List," 1878, Proc. Amer. Philos. Soc., vol. 17, p. 643), and from Edmonton, Alberta, July 16, 1920, are two specimens on one pin in the Frost collection, which apparently belong to the two distinct species. These require field evidence of a biological nature to supplement the specific value of the differences in structure of the claws, but it is significant that *brevicornis* has been found on dead willow (Frost), *populi* on aspen bark (Schwarz) and *bifasciatus*, reared from linden (Champlain).

—H. S. Barber.

MECONEMUS INFUSCATUS Fahraeus

Ischnocerus infuscatus FAHRAEUS, Schönherr, Gen. et Sp. Curc., 1839, vol. 5, p. 192.

This species occurs in the Southern States from South Carolina [3] to Texas and in Mexico. The United States National Museum material is from Brownsville, Devil's River, Columbus and Victoria, Tex.; Baton Rouge and New Orleans, La.; Key West, Biscayne, Enterprise, and Bartow, Fla.; having been collected by Messrs. Hubbard, Schwarz, Barber, Soltau, and Mitchell.

The principal diagnostic characters are illustrated (figs. 50–62). The joints of the antennal club are longer than in *Discotenes*. The view of the underside of the head (fig. 51) shows many differences from *Discotenes*. The two sexes may be separated aside from the differences in the antennae by the side view of the beak. (Fig. 50.) The protarsal claw (fig. 61) is quite different from *Discotenes*. A view of the female genitalia (fig. 62) is also given which also shows the pygidial groove. A fine sketch of the thoracic sternal plates is presented. (Fig. 58.) Finally the mouth parts have been illustrated from slide mounts.

The labrum (fig. 52) really consists of two parts, a basal transparent part, the postlabrum or clypeus, and a yellowish transparent part, the true labrum. It is slightly emarginate at apex, provided with a few apical bristles. Beneath (fig. 53) the epipharynx is finely papillose in a semicircular area at the base of the labrum, and converging on this area is a semicircle of marginal blunt spines which form a bristling network.

The mandibles (figs. 56, 57) differ only in specific characters from *Discotenes*.

The maxillae (fig. 54) are complete, being composed of cardo, stipes with a basal piece and the main part to which is attached the 4-jointed palpus, the elongate fingerlike galea and the tactile lacinia. On the main part of stipes is a lobe with a row of strong bristles just below the attachment of the palpus. The basal joint of the palpus is small, the second large and inflated; the third smaller but larger than the first; and the fourth elongate, tapering, but truncate at apex; the palpus has very few hairs or spines. Galea is clad with fine hairs or bristles, is diagonally truncate at apex which is provided with a brush of bristles. Lacinia is provided on the outer side with a strong double row of blunt spines.

The labium (fig. 55) of the adult is transverse, subtrapezoidal, brownish in color with two long spines at the basal angles. The ligula is separated only by a difference of color, being yellow.

[3] It has since been collected at Chesapeake Beach, Md., and on the Potomac River, 13 miles above the Capital, by H. S. Barber.

It is strongly bilobed with two long bristles at the middle of the emargination. The palpi are attached on the diagonal sides of the labium, and three jointed, the first and third subequal, the second shortest; joints dark brown, but yellow at apex, second joint with several very long bristles on inner side; third joint with a few shorter bristles. The hypopharynx or inner surface of labrum and ligula has two series of blunt crowded bristles separated from each other by the raised median line.

Thus the interior of the mouth is a network of bristles from all directions.

This genus differs from *Discotenes* by having the lobes of the ligula much stronger.

Figures 59 and 60 illustrate the wing structure.

PLATYSTOMINAE, new subfamily

TABLE OF NORTH AMERICAN TRIBES OF PLATYSTOMINAE

Beak with sides parallel or almost so. Body oblong or oval; rostral scrobes foveiform----------Platystomini, new tribe.
Beak very short, narrower in front, trapezoidal; scrobes sulciform.
Brachytarsini, new tribe.

PLATYSTOMINI, NEW TRIBE

Platyrrhini BEDEL 1885.

TABLE OF NORTH AMERICAN GENERA OF PLATYSTOMINI

1. Tarsi with third joint wider, deeply bilobed, visible from above----------2.
   Tarsi with third joint bilobed, not visible from above----------7.
2. Hind angles of prothorax not directed outward----------3.
   Hind angles of prothorax directed outward; front coxae contiguous----------6.
3. Front coxae contiguous or nearly so----------4.
   Front coxae well separated by the prosternum----------5.
4. Claws almost cleft, body elongate-cylindrical, eyes emarginate.
   Phoenicobiella Cockerell.
   Claws feebly appendiculate, body stout subcylindrical, eyes oval.
   Piesocorynus Dejean.
5. Eyes rounded----------Pseudanthribus, new genus.
   Eyes broadly emarginate----------Toxonotus Lacordaire.
   Eyes with a short, shallow emargination---Platystomos (Helling) Schneider.
6. Eyes emarginate----------Eusphyrus LeConte.
7. Mandibles with a tooth on the ventral edge----------Euparius Schönherr.

Genus PHOENICOBIELLA Cockerell

Phoenicobius LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 401. *Type*, *chamaeropis* LeConte (not Mörch 1852).
Phoenicobiella COCKERELL, Ent. News, 1906, vol. 17, p. 243.

TABLE OF SPECIES OF PHOENICOBIELLA

Species dark brown, tessellated with black and yellowish--chamaeropis LeConte.
Species very light yellowish brown, with slightly darker tessellations.
schwarzi Schaeffer.

PHOENICOBIELLA CHAMAEROPIS LeConte

Phoenicobius chamaeropis LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 401.

Common on fresh cut leaves of palmetto, *Sabal palmetto* (*Chamaerops*) in Florida (LeConte, 1876; Schwarz, 1878). It lives in the leaf stems (Schwarz). It is also at hand from Savannah, Georgia (G. Noble) and New Orleans, Louisiana, May 7, June 2 (H. Soltau).

PHOENICOBIELLA SCHWARZI Schaeffer

Phoenicobiella schwarzi Schaeffer, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 273.

Collected inside of dead leaf stem of *Sabal mexicana*, August 14, by C. H. T. Townsend at Brownsville, Tex.[4] It was also taken June 7, 1895, by E. A. Schwarz at Brownsville, Tex.

Genus PIESOCORYNUS Dejean

Piesocorynus Dejean, Cat. Coleop., 1837, ed. 3, p. 257. *Type, dispar* (Gyllenhal), monotype.

Piezocorynus Schönherr, Gen. et Sp. Curc., 1839, vol. 5, pt. 1, p. 250. *Type, dispar* (Dejean) Gyllenhal by original designation.

TABLE OF NORTH AMERICAN SPECIES OF PIESOCORYNUS[5]

1. Prothorax with two shallow depressions and three elevations occupying the middle third; antennae not very slender; eighth antennal joint longer than the ninth in the male and equal in the female; elytra with discal areas lighter brown ..... plagifer Jordan.
   Prothorax without impressions or elevations; antennae very slender; eighth antennal joint equal to the ninth in the male and shorter than the ninth in the female ..... 2.
2. Pubescence mottled yellow brown and black ..... mixtus LeConte.
   Pubescence nearly black, elytra more tuberculate ..... moestus LeConte.
   Blackish brown, alternate elytral intervals tessellated with black and yellowish spots (female unknown) ..... tesselatus Schaeffer.

[4] Schaeffer, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 274.

[5] After the above treatment of *Piesocorynus* was written by Pierce, an additional species of the genus *P. virginicus* was described by Leng (Journ. N. Y. Ent. Soc., vol. 26, 1918, p. 11). The introduction of this species into Pierce's key brings about troublesome complications that are easiest avoided by adopting a somewhat different classification; accordingly, a new synoptic key has been prepared. The writer has been very materially aided by the generosity of Mr. Charles Schaeffer, who loaned the holotype of *Piesocorynus tesselatus* Schaeffer, and of Mr. W. T. Davis, who presented a paratype of *P. virginicus* Leng to the National Museum.

In the key which follows mention is made of the "postscutellar carina." (See p. 1.) This structure is visible only when the prothorax is bent downward or otherwise slightly separated from the mesothorax; it originates just below the lateral extremity of the dorsal transverse carina and extends inwardly along the deflexed, subvertical face of the pronotal base, between the transverse carina and the extreme basal margin of pronotum.

The elytra of all the species are minutely granulate; this feature, though largely obscured by the vestiture, can generally be observed on the basal median callus, or on and

PIESOCORYNUS PLAGIFER Jordan

Piezocorynus plagifer JORDAN, Novitates Zoologicae, 1904, vol. 11, p. 277; name proposed for *P. dispar* LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 402 (not Gyllenhal 1833).

Feeds as adult on fungus growing on trunks of dead beech (*Fagus americana*); taken in abundance by C. Dury near Cincinnati, Ohio (Beutenmüller, 1893). On old logs and under loose bark in the District of Columbia (Ulke, 1902, p. 55). Occurs in Ohio, Kentucky, Mississippi, and Georgia.

PIESOCORYNUS MIXTUS LeConte

Piezocorynus mixtus LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 402.

Taken under the same circumstances as *plagifer* (Beutenmüller, Ulke). Occurs in New York, Maryland, Ohio, Virginia, Florida, Covington, La., and Columbus, Tex.

PIESOCORYNUS MOESTUS LeConte, J. E.

Anthribus moestus LECONTE, Ann. Lyc. Nat. Hist. New York, 1824, vol. 1, p. 172, pl. 2, fig. 13 (*capillicornis* Say, Journ. Acad. Nat. Sci. Phila., vol. 5, No. 2, p. 249).

Rare on dead branches in Florida (Schwarz, 1878). On old logs and under loose bark in District of Columbia (Ulke, 1902, p. 55). Also taken at Covington, La., May 28–June 14 (H. Soltau).

PIESOCORYNUS TESSELATUS Schaeffer

Piezocorynus tesselatus SCHAEFFER, Trans. Amer. Ent. Soc., 1906, vol. 32, p. 274. Described from the Huachuca Mountains, Ariz.

PSEUDANTHRIBUS, new genus

Anthribus LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, pp. 402, 403 (not Geoffroy 1762).

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just behind the humeral callus. The granules are somewhat coarser in *virginicus* than in any of the other species. Although special and easily perceived sexual differences are present in four of the five species, there seems to be no well-marked sex character affecting them all; the basal segments of the abdomen are generally slightly flattened in males, evenly convex in females, but this distinction is often impossible to appreciate. The tarsal claws of all the species have a broad basal tooth.

Localities cited are for specimens in the United States National Museum collection.

Supplementary key to the North American species of *Piesocorynus:*

1. Elytra with an extensive, ochreous, discal area (that contrasts strongly with the black sides) extending longitudinally from just behind the scutellar callus to declivity, wider in basal half where it covers the first five intervals, than towards declivity where it entirely covers only the first and second intervals, and occasionally the third and fourth, in part; sides of elytra black, except ninth interval which is tessellated; pronotum with three distinct, slightly postmedian elevations arranged in a transverse row, the central one more prominent; postscutellar carina lacking; pronotal punctures shallow and extremely dense, small at apex but becoming much

TABLE OF NORTH AMERICAN SPECIES OF PSEUDANTHRIBUS

The following table is from Schaeffer (1904):

1. Pubescence of thorax and elytra uniform, dense, yellowish gray, without erect tufts of scales ..... lividus LeConte.
   Pubescence grayish white, yellow and brown forming denser brush-like tufts on thorax and elytra ..... 2.
2. Elytra with basal fascia or spot ..... 3.
   Elytra without basal fascia or spot ..... 5.
3. Elytra with a well-defined large transverse white spot in front of middle not extending to the side margin ..... cornutus Say.
   Elytra with more or less distinct fascia of dense white or ochreous hairs extending to the side margin ..... 4.
4. Thorax without larger black spot near each hind angle, the middle and posterior tufts of hairs on the elytra more widely separated from each other than the first and second, the line of denser white and yellowish hairs convergent in front ..... vagus Horn.
   Thorax with one black spot each side near hind angles, the distance between the first and second elytral tuft equal to that between the second and third, the lines of whitish and ochreous hairs at apex of thorax divergent in front ..... bipunctatus Schaeffer.
5. Elytral tufts equidistant, middle thoracic tuft large and black, the arcuate lines convergent in front but very indistinctly defined at apex. penicellatus Schaeffer.

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coarser near base where the thin interstices show a marked tendency to assume a transverse arrangement; antennae heavy, equal to or one-half longer than body in male, of normal length in female.

Male.—Eighth segment of antenna much longer than ninth, generally equal to, or longer than, entire club, the latter with its segments obliquely emarginate and somewhat asymmetric; mid-tibia a little more abruptly expanded internally at apex than in female, but without apical spine. In a few specimens a feeble longitudinal carina is present on middle of first abdominal segment.

Female.—Antennae somewhat more than half as long as body, the eighth segment subequal to or slightly shorter than ninth; club relatively broader, its segments obliquely emarginate.

Length, 4.5 to 7 mm. Georgia, Mississippi, Kentucky, Illinois, Ohio, and Maryland ..... plagifer Jordan.
(dispar LeConte, not Gyllenhal).

1*a*. Elytra without a discal area as above; postscutellar carina present; pronotum without marked elevations (in *mixtus* and *moestus* a less prominent median one is sometimes developed); pronotal punctures very dense, nearly uniform in size and distribution, the thin interstices forming a regular network and not transversely arranged near base; antennae much thinner, shorter than body in both sexes, eighth segment of normal length ..... 2.

2. Elytra with an extensive black discal area extending from base to declivity, covering about five intervals on each elytron, broader at base, rarely with some paler mottlings; sides of elytra pale and more or less tessellated; pronotum without elevations; postscutellar carina (in the four specimens seen) feeble, developed for a short distance at sides only.

Male.—Middle tibia with its inner apical angle produced into a broad, flat spine; antennae about three-fourths as long as body, the eighth segment equal to ninth or nearly so, the club broad, flattened, and with its segments obliquely emarginate.

Female.—Antennae a little shorter, eighth segment shorter than ninth, tenth segment relatively longer than in male; club narrower and less flattened, and with its segments evenly emarginate.

Four specimens seen: One male paratype from Wingina, Va.; one female, Baton Rouge, La. (O. W. Rosewall); one female, Cupids Bower Island, Md. (R. C. Shannon); one female, Tampa, Fla. (Hubbard and Schwarz) ..... virginicus Leng.

PSEUDANTHRIBUS BIPUNCTATUS Schaeffer

Anthribus bipunctatus SCHAEFFER, Journ. N. Y. Ent. Soc., 1904, vol. 12, p. 235

Described from Brownsville Tex., where it was found in April and May.

PSEUDANTHRIBUS CORNUTUS Say

Anthribus cornutus SAY, Desc. new species Curculionites, 1831, p. 4.

Adults found on honey locust (*Gleditsia triancanthos*) by C. Dury and bred from stems of tamarix (*Tamarix gallica*) by Popenoe (Beutenmüller, 1893). Not rare on dead branches in the District of Columbia (Ulke, 1902, p. 55). Bred from stems of cotton (*Gossypium hirsutum*) July 13, 1895, at San Diego, Tex. Taken on *Quercus* sp. at Longview, Tex., March 26, 1908, by E. S. Tucker; on *Acacia* sp. at Sabinal, Tex., June 3, 1910 by F. C. Pratt. Has been taken at lights at Gregory and Brownsville, Tex. Occurs in the District of Columbia, Georgia, Florida, Alabama, Tennessee, Louisiana, Illinois, and Texas.

(The Tampa, Fla., female has disk of elytra tesselated much as in one of the unusually dark specimens of *mixtus*, and is similar in most structural characters also. It has, however, coarser elytral granulations, an even pronotum, and a feeble postscutellar carina, and is therefore placed with *virginicus*).

2*a*. Elytra subevenly tessellated over entire surface, or at least never with an extensive discal area that contrasts in color with sides (*mixtus* sometimes has a dark rectangular scutellar spot); postscutellar carina apparently well developed, extending from side to side, or only narrowly interrupted at middle, in the specimens examined; mid tibia of male without a spine at apex; antennae noticeably thin, the club only moderately flattened and with its segments symmetrically, not obliquely, emarginate ..... 3.

3. First segment of fore tarsus, as seen from above, pale on basal one-third only, apical two-thirds black; ground color of body above blackish-brown, the elytral tessellations unusually even and distinct; pronotum without prominences; postscutellar carina strong.

Male.—Second segment of abdomen without acute tubercle, third segment shallowly concave at middle; eighth antennal segment heavy, conically widened towards apex where its width is a little more than half its length.

Length of male holotype, 6.5 mm. (female unknown). Huachuca Mountains, Ariz. ..... tesselatus Schaeffer.

3*a*. First segment of fore tarsus pale in basal half or basal three-fourths, black apically; second abdominal segment of male with an acute tubercle on median line near second suture; eighth antennal segment slender (male and female), its width at apex distinctly less than half its length; size smaller; eastern United States ..... 4.

4. Ground color of elytra normally ochreous, rarely darker ferruginous, the pronotum with blackish and reddish mottlings, the generally conspicuous elytral tessellations composed of black and whitish spots; a transverse rectangular dark scutellar spot often present; of the dark tessellations, those across middle of elytra on third and fifth intervals are larger, and are generally nearly opposite each other, giving the appearance of a broken, transverse bar; pronotum generally with a quite distinct median prominence, rarely with feeble lateral ones also.

Length, 3 to 5.5 mm. New York, Maryland, Ohio, Virginia, North Carolina, Georgia, and Texas ..... mixtus LeConte.

4*a*. Ground color above very dark, almost black, with a smoky-gray to slate-gray tinge; pronotal surface uniform black (excluding the usual, short, apical, white line and occasional small spots of whitish pubescence); elytral tessellations obscure, generally formed by black spots which, in some specimens, alternate with gray spots; pronotum with median elevation less frequently developed and less prominent, than in *mixtus*.

Length, 2.75 to 5.25 mm. Louisiana, Florida, and Maryland ..... moestus LeConte.

—L. L. BUCHANAN.

PSEUDANTHRIBUS LIVIDUS LeConte

Anthribus lividus LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 403.

Taken at Sebastian, Fla., April 7, and at Savannah, Ga. (Hubbard and Schwarz).

PSEUDANTHRIBUS PENICELLATUS Schaeffer

Anthribus penicellatus Schaeffer, Journ. N. Y. Ent. Soc., 1904, vol. 12, p. 236.

Described from Brownsville, Tex.

PSEUDANTHRIBUS VAGUS Horn

Anthribus vagus Horn, Proc. Cal. Acad. Sci., 1894, vol. 4, p. 448.

Described from Southern California.

Genus PLATYSTOMOS (Hellwig) Schneider

Platystomos (Hellwig) Schneider, Neuestes Mag., 1791, vol. 1, pt. 1, p. 21, footnote. Type, *albinus* Linnaeus, hereby designated.

Platystomos Hellwig, Schneider's Neuestes Mag., 1792, vol. 1, pt. 4, p. 393.

Macrocephalus Olivier, Encycl., 1789, vol. 4, p. 36 (not Swederus 1787). *Type* of genus, *albinus* Linnaeus, designated by Bedel, 1881.

PLATYSTOMOS ALBINUS Linnaeus

Curculio albinus Linnaeus, Syst. Nat., 1758, ed. 10, p. 385.

Taken in old wood (Rivers, 1886). In Europe this species breeds in dead wood and dry hedgerows of oak (*Quercus*), birch (*Betula*), elm (*Ulmus*), and willow (*Salix*) (Bedel, 1885). Breeds in dead wood of *Fagus*, *Betula*, *Salix*, *Ulmus*, *Quercus*, and *Carpinus* (Schaufuss, 1914, 1028). Breeds in decaying wood of *Fagus silvatica*, *Ulmus*, *Crataegus oxyacantha*, *Carpinus betulus* Linnaeus, *Quercus*, *Salix*, and *Betula alba* (Kleine, 1910 47).

Genus TOXONOTUS Lacordaire

Toxonotus Lacordaire, Gen. Coleop., 1866, vol. 7, pp. 575, 576. *Type, fascicularis* Schönherr, monotype.

TOXONOTUS FASCICULARIS Schönherr

Anthribus fascicularis Schönherr, Gen. et Spec. Curc., 1833, vol. 1, p. 132.

This species is found in Cuba, and at Key West, Biscayne, and St. Lucie, Fla.

Genus EUSPHYRUS LeConte

Eusphyrus LeConte, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 399. *Type, walshii* LeConte, monotype.

EUSPHYRUS SCHWARZI, new species

Three specimens taken at Key West, Fla., March 8, 13, and 22, 1912, by E. A. Schwarz, differ from the other described species in having the pronotum broadly rounded at sides, due to strong development of the lateral carina from basal angles to before middle and in the more conspicuous tessellate areas of white pubescence. Shapes of the pronotum, antenna, rostral apex, eye, and scrobe are shown in Figure 63 in comparison with *rectus* (fig. 64) and *walshii* (fig. 65).

Type and two paratypes.—Cat. No. 41368, U.S.N.M.

EUSPHYRUS ARIZONENSIS Schaeffer

Eusphyrus arizonensis SCHAEFFER, Trans. Amer. Ent. Soc., 1906, vol. 33, p. 272.

This species was described from the Huachuca Mountains, Ariz. It is not represented in the national collection.

EUSPHYRUS RECTUS Schaeffer

Eusphyrus rectus SCHAEFFER, Trans. Amer. Ent. Soc., 1906, vol. 33, p. 271.

Twenty-five Texan specimens are tentatively referred to this species with much doubt because of the conspicuous differences in vestiture. Figure 64 is drawn from one of the four specimens collected at the type locality, Brownsville. Other localities represented are Columbus, San Diego, Victoria, San Antonio, Beeville, and Devils River, the two latter localities probably representing distinct species.

EUSPHYRUS WALSHII LeConte

Eusphyrus walshii LECONTE, Proc. Amer. Philos. Soc., 1876, vol. 15, p. 400.

Bred from twigs of black locust (*Robinia pseudacacia*) (Schwarz, Proc. Ent. Soc. Wash., 1890–91, p. 74). Breeds in dead wood of deciduous trees (Smith, 1900). Bred from twigs of dead fig (*Ficus* sp.) (Townsend, 1903, p. 99). (See fig. 65.)

Genus EUPARIUS Schönherr

Euparius SCHÖNHERR, Isis von Oken, 1823, Heft 10, p. 1135. *Type* (*lunatus* Fabricius) *marmoreus* Olivier, hereby designated.

Euparius SCHÖNHERR, Curc. Disp. Meth., 1826, p. 36. *Type*, *tigris* Schönherr, by original designation. Not preoccupied by *Euparia* Lepeletier-Serville, 1825.

Cratoparis DEJEAN, Cat. Col., 1837, ed. 3, p. 257. New name for *Euparius*.

The weevils of this genus so far as known breed in fungi.

EUPARIUS LUGUBRIS Olivier

Macrocephalus lugubris OLIVIER, Entomologie, 1795, vol. 4, no. 80, p. 13.

In fungi growing on old logs in District of Columbia (Ulke, 1902, p. 55). Occurs in the Atlantic States, abundant southwardly and as far west as northeast Texas.

EUPARIUS MARMOREUS Olivier

Macrocephalus marmoreus OLIVIER, Entomologie, 1795, vol. 4, no. 80, p. 12.

Breeds in white fungus on dead trees. Specimens of fungus were collected at Tallulah, La., July 15, 1909, from which adults emerged November 20, 1909. The species has been found on dead oak (Beutenmüller, 1890); feeding on white fungus covering base of a live water oak (*Quercus phellos*) at Logansport, La. (Pierce, 1907, Neb. Hort. Soc., p. 295); in tree fungus at Victoria, Tex., November 15 (J. D. Mitchell); at light, Dallas, Tex., May 27, 1905 (C. R. Jones). Abundant in the Atlantic States. (See figs. 66, 67.)

BRACHYTARSINI, NEW TRIBE

The oldest generic name in the group is *Amblycerus* Thunberg [6] [7] (1815), which is excluded by Bridwell in footnote 7.

TABLE OF GENERA BRACHYTARSINI

1. Thoracic carina not extending forward on sides ..... Anthribulus LeConte.
   Thoracic carina extending forward on sides ..... 2.
2. Posterior angles of thorax salient and acuminate; eyes usually very prominent ..... 3.
   Posterior angles of thorax rectangular; eyes moderately or hardly prominent ..... 4.
3. Lateral carina complete, very salient ..... Pseudobrachytarsus, new genus.
   Lateral carina prominent in posterior half only ..... Brachytarsus Schönherr.
4. Lateral carina complete ..... Araeoderes Schaeffer.
   Lateral carina extending only part way ..... Brachytarsoides, new genus.

This tabulation sets off the two predaceous genera *Pseudobrachytarsus* and *Brachytarsus* from the vegetarian genera.

The type species of *Pseudobrachytarsus*, *A. fasciatus* Forester (*scabrosus* Paykull), is European and lives as a larva on Coccidae and transforms under the dried shell of *Lecanium genevense* Tar-

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[6] Nov. Act. Reg. Soc. Scient. Upsaliensis, vol. 7, pp. 106, 109, 121.

[7] It is impossible to accept the designation by Crotch (1870) of *Amblycerus nebulosus* Thunberg 1815 as genotype of *Amblycerus* because of insufficient bibliographical indication to determine the identity of that species which is not described in the original reference and might refer to *Anthribus nebulosus* Forster (1771), *Bruchus nebulosus* Olivier (1795), or *Macrocephalus nebulosus* Olivier (1795). I hereby designate as genotype of *Amblycerus* Thunberg (1815) (not Raffray 1895) *Bruchus robiniae* Fabricius (1781) = *Spermophagus robiniae* Gyllenhal (1833) (excluding description). This species is not apparently congeneric with *Spermophagus titivilitius* Boheman (1833), genotype of *Spermophagus* Schönherr (1833).—J. C. Bridwell.

gioni Tozzetti on *Crataegus oxyacantha*, *Pulvinaria carpini* Linnaeus on *Carpinus*, *Lecanium corni* Bouché and *L. persicae* Fabricius, *Gossyparia spuria* Modeer and other Coccidae. The adults feed on the buds of young plants and have been taken on *Aesculus hippocastanum*, *Prunus cerasus*, *Carpinus betulus*, *Crataegus oxyacantha*, *Malus malus*, *Juglans regia*, *Picea excelsa*, *and Pinus silvestris.*

The type of *Brachytarsus* is *variegatus* Fourcroy (*varius* Fabricius). The larva lives on the scales of *Physokermes piceae* Schrank on *Abies* and *Pinus* and other conifers.

The writer has not yet perfected a suitable table of species of *Brachytarsoides*, of which *griseus* LeConte is hereby designated type.

The following notes on the habits of our American species will be of interest.

Brachytarsoides alternatus Say breeds in many plants. It is recorded from *Zea mays*, *Vigna unguiculata*, *Pisum sativum arvense*, *Ipomoea pandurata* (in the fungus *Aystopus ipomoea-panduranae*), *Elymus virginicus*, *Sideranthus phyllocephalus.* R. A. Cushman bred it from dry galls of *Ipomoea lacunosa*, at Dallas, Tex., April 9, 1907. H. S. Smith bred it from heads of *Grindelia squarrosa* collected at Clarendon, Tex., October, 1908. V. I. Safro bred it from heads of *Grindelia squarrosa nuda* at Childress, Tex., July 29, 1908. S. Goes found it on flowers of *Sideranthus phyllocephalus* at Ennis, Tex., October 7, 1905, and on *Ambrosia* at Mexia, Tex., June 12, 1905. A. C. Morgan and W. E. Hinds found it hibernating in cotton bolls at Corpus Christi, Tex., March 23, 1905. A. L. Quaintance recorded (1907) that the eggs were deposited with excrement and partly digested food and placed loosely on bases of kernels of shelled corn. The life cycle was six or seven weeks. The writer found the species laid its eggs in the tips of new lateral stems of *Sideranthus.* The larvae feed in these stems surrounded by pulverized remains. They pupate in the tips of the stems, or even in the main stem, becoming so numerous that they absolutely riddle the stem in which they are breeding. They may be described as pseudopods. It is parasitized by braconids and *Microdontomerus anthonomi* Crawford.

Brachytarsoides griseus LeConte was taken on *Aphanostephus skirrobasis* flower heads at Cuero, Tex., April 6, 1906, and at Calvert, Tex., May 18, 1907, by R. A. Cushman.

Brachytarsoides limbatus Say was first bred from the flower heads of *Helenium tenuifolium* by E. A. Schwarz. It also breeds in *Helenium microcephalum*, and has been collected on *Rudbeckia amplexicaulis* and *Xanthium.* The larvae feed among the seeds of *Helenium* and pupate in the cell they have made. In *H. microcephalum* the pupal cell is sometimes in the columnar portion of the head.

Brachytarsoides paululus Casey is recorded by Blatchley and Leng from the seed pod of *Staphylea trifolia.*

Brachytarsoides plumbeus LeConte was found abundant on *Coreopsis cardaminefolia* at San Antonio, Tex., May 4, 1905, and on *Argemone platyceras rosea* at Cotulla, Tex., May 5, 1905, by J. C. Crawford and the writer.

Brachytarsoides riddelliae Schaeffer was originally described from (*Riddellia*) *Psilostrophe* sp. at Tucson, Ariz. It was taken on *Ratibida columnaris* at Del Rio, Tex., May 1, 1907, by F. C. Bishopp.

Brachytarsoides sticticus Boheman (*variegatus* Say) has been recorded as depredating wheat bins in New York. E. A. Schwarz bred it from smut of corn. Chittenden says the larvae are fungus feeders and breed in smut of wheat and corn. Blatchley and Leng record it on flowers of *Cephalanthus occidentalis* in Indiana.

Brachytarsoides tomentosus Say occurs on *Ambrosia artemisiaefolia.*

Brachytarsoides vestitus LeConte breeds in flower heads of *Helenium tenuifolium.*

Anthribulus rotundatus LeConte is recorded on the flowers of *Vaccinium* by Blatchley and Leng.

I find no record of the host of *Araeoderes texanum* Schaeffer.

Family CHORAGIDAE Des Gozis (1882)

Most of the insects of this family have the ability to jump.

TABLE OF SUBFAMILIES OF CHORAGIDAE

Elytra striate; labial palpi four jointed----------Choraginae, new subfamily.
Elytra not striate----------Xenorchestinae, new subfamily.

Choraginae, new subfamily

This subfamily contains three tribes:
Notioxenini with prothoracic carina antebasal.
Choragini with prothoracic carina basal or subasal.
Homoeoderini with prothoracic carina absent.
Only the Choragini are represented in our fauna.

TABLE OF NORTH AMERICAN GENERA OF CHORAGINI

Antennae with second joint shorter than the first--------Araecerus Schönherr.
Antennae with second joint as long as the first----------Choragus Kirby.
Holostilpna Jordan.

The type of *Araecerus* is *fasciculatus* DeGeer (*coffeae* Fabricius). This species known variously as the coffee bean weevil, the areca-nut weevil, and the ubiquitous bean weevil is tropicopolitan or subtropicopolitan, breeding in many kinds of vegetable matter. It breeds in

green and dry cornstalks, china berries, dry cotton bolls, castor beans, dry figs, stored betel nuts, coffee berries, ginger, chinese figs, decayed leaves, St. Ignatius bean (*Strychnos ignatii*), chocolate beans, mace, nutmeg, Cassia pods, dry oranges, dried apples, dry peaches, koa seed (Acacia pod), mamani seed (*Sophora chrysophylla*), kola nuts (*Sterculia acuminata*), dead wood, St. John's bread seed (*Ceratonia siliqua*).

The larvae are white or pinkish. They pupate in their feeding cell surrounded by the powdered excrement. The adults have not the jumping power of some of the related genera.

In Figure 68 I have drawn the underside of the head, to show the 4-jointed labial palpi and 3-jointed maxillary palpi; and in Figure 69 the undersides of the thorax.

Holostilpna nitens LeConte, the type of the genus, has leaping power. It is found on dead wood of white oak in Maryland and the District of Columbia.

The type of *Choragus* is the European *sheppardi* Kirby. It burrows in the dead branches of *Crataegus*, *Castanea*, *Fagus*, *Pyrus*, *Quercus*, *Tilia*, and *Salix*. The legs of the larvae are replaced by pseudopods.

The European *C. piceus* Schaum breeds in dead branches of *Ulmus campestris* and *Prunus spinosa*.

Choragus sayi breeds in the United States in dead branches of *Fagus*.

Choragus zimmermanni LeConte occurs on *Liquidambar styraciflua*.

Xenorchestinae, new subfamily

TABLE OF NORTH AMERICAN GENERA OF XENORCHESTINAE

Upper surface smooth.....Xenorchestes Wollaston.
Prothorax punctured; elytra with irregular double rows of punctures.
Euxenus LeConte.

The weevils of this subfamily have jumping power.

The type of *Xenorchestes* is *saltitans* Wollaston.

Xenorchestes americanus Motschulsky occurs along the Gulf Coast in Texas, Alabama, and Florida. It is found on bushes.

Euxenus punctatus LeConte, the type of its genus, is found on dry palmetto leaves (*Sabal palmetto*) in Florida.

Euxenus piceus LeConte is also found on *Sabal palmetto* in Florida.

EXPLANATION OF PLATES

("W D P," drawn by W. Dwight Pierce; "H B," drawn by Harry Bradford)

Plate 1

Figure 1. *Discotenes nigrotuberculata* Schaeffer. Face, female. (H B)
2. *Discotenes nigrotuberculata* Schaeffer. Side view of female head. (H B)
3. *Discotenes nigrotuberculata* Schaeffer. Mouth parts, female. (H B)
4. *Discotenes nigrotuberculata* Schaeffer. Sternal sclerites, female. (W D P and H B)
5. *Discotenes nigrotuberculata* Schaeffer. *a*. Right mandible, ventral view. (W D P)
   b. Right mandible, dorsal view. (W D P)
6. *Discotenes nigrotuberculata* Schaeffer. Maxilla, female. (W D P and H B)
7. *Discotenes nigrotuberculata* Schaeffer. Labium, female, outer view. (W D P)
8. *Discotenes nigrotuberculata* Schaeffer. Antenna of male and female. (H B)
9. *Discotenes nigrotuberculata* Schaeffer. Wing, female. (W D P)
10. *Discotenes nigrotuberculata* Schaeffer. Protarsus. (H B)
11. *Discotenes nigrotuberculata* Schaeffer. Protarsal claw. (H B)
12. *Discotenes nigrotuberculata* Schaeffer. Pygidium, female, showing groove. (W D P)
13. *Discotenes nigrotuberculata* Schaeffer. Genitalia of female. (W D P)

Plate 2

Figure 14. *Ormiscus angulatus* Pierce. Head and prothorax. (W D P)
15. *Ormiscus angulatus* Pierce. Prothorax in side view. (W D P)
16. *Ormiscus angulatus* Pierce. Prosternum. (W D P)
17. *Ormiscus saltator* LeConte. Face. (W D P)
18. *Ormiscus saltator* LeConte. Head in side view. (W D P)
19. *Ormiscus saltator* LeConte. Mouth parts. (W D P)
20. *Ormiscus saltator* LeConte. Head and prothorax. (W D P)
21. *Ormiscus solidus* Pierce. Prothorax. (W D P)
22. *Ormiscus solidus* Pierce. Tarsal claws. (W D P)
23. *Tropideres bimaculatus* Olivier. Face. (W D P)
24. *Tropideres bimaculatus* Olivier. Underside of head. (W D P)
25. *Tropideres bimaculatus* Olivier. Head in side view. (W D P)
26. *Tropideres bimaculatus* Olivier. Protarsal claw. (W D P)
27. *Tropideres bimaculatus* Olivier. Metatarsal claw. (W D P)
28. *Tropideres barberi* Pierce. Protarsus. (W D P)
29. *Gonotropis gibbosus* LeConte. Face, male. (W D P)
30. *Gonotropis gibbosus* LeConte. Head in side view. (W D P)
31. *Gonotropis gibbosus* LeConte. Underside of beak, male. (W D P)
32. *Gonotropis gibbosus* LeConte. Inner view of maxilla, male. (W D P)
33. *Gonotropis gibbosus* LeConte. Pronotum, male. (W D P)
34. *Gonotropis gibbosus* LeConte. Prothorax in side view, male. (W D P)
35. *Gonotropis gibbosus* LeConte. Sternites. (W D P)
36. *Gonotropis gibbosus* LeConte. Right protarsal claw, male. (W D P)

Plate 3

Figure 37. *Eurymycter fasciatus* Olivier. Face, male. (W D P)
38. *Eurymycter fasciatus* Olivier. Vertex of head. (W D P)
39. *Eurymycter fasciatus* Olivier. Pronotum, male. (W D P)
40. *Eurymycter fasciatus* Olivier. Upper portion of thorax and elytra, side view. (W D P)
41. *Eurymycter tricarinatus* Pierce. Vertex of head, male type. (W D P)
42. *Eurymycter tricarinatus* Pierce. Underside of beak, male type. (W D P)
43. *Eurymycter tricarinatus* Pierce. Right metatarsus, male type. (W D P)
44. *Eurymycter tricarinatus* Pierce. Right metatarsal claw, male type. (W D P)
45. *Allandrus populi* Pierce. Head and beak. (W D P)
46. *Allandrus populi* Pierce. Pronotum. (W D P)
47. *Allandrus populi* Pierce. Metatarsal claw, female. (W D P)
48. *Allandrus bifasciatus* LeConte. Underside of beak. (W D P)
49. *Allandrus bifasciatus* LeConte. Metatarsal claws, female. (W D P)
50. *Meconemus infuscatus* Fahraeus. Side view of beak, female. (H B)
51. *Meconemus infuscatus* Fahraeus. Underside of head, male. (H B)
52. *Meconemus infuscatus* Fahraeus. Labrum, outside view. (W D P)
53. *Meconemus infuscatus* Fahraeus. Labrum, inside view. (W D P)
54. *Meconemus infuscatus* Fahraeus. Maxilla, outer view, male. (W D P and H B)
55. *Meconemus infuscatus* Fahraeus. Labium, ventral view, male. (W D P and H B)
56. *Meconemus infuscatus* Fahraeus. Right mandible, dorsal view. (W D P)
57. *Meconemus infuscatus* Fahraeus. Left mandible, ventral view (W D P)

Plate 4

Figure 58. *Meconemus infuscatus* Fahraeus. Sternal sclerites, male. (H B)
59. *Meconemus infuscatus* Fahraeus. Wing. (W D P)
60. *Meconemus infuscatus* Fahraeus. Base of wing. (W D P)
61. *Meconemus infuscatus* Fahraeus. Protarsal claw, male (H B)
62. *Meconemus infuscatus* Fahraeus. Female genitalia, dorsal view. (W D P and H B)
63. *Eusphyrus schwarzi* Pierce. *a*, pronotum; *b*, tip of beak; *c*, antenna; *d*, scrobe and eye. (W D P)
64. *Eusphyrus rectus* Schaeff. *a*. pronotum; *b*. tip of beak; *c*, antenna; *d*, scrobe and eye. (W D P)
65. *Eusphyrus walshii* LeConte. *a*, pronotum; *b*, tip of beak; *c*, antenna; *d*, scrobe and eye. (W D P)
67. *Euparius marmoreus* Oliver. Head and prothorax. (H B)
68. *Araecerus fasciculatus* DeGeer. Underside of head. (W D P)
69. *Araecerus fasciculatus* DeGeer. Sternal plates. (W D P)

Plate 5

Figure 66. *Euparius marmoreus* Olivier. (H B)

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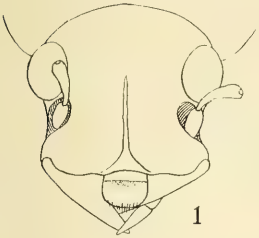
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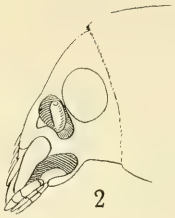
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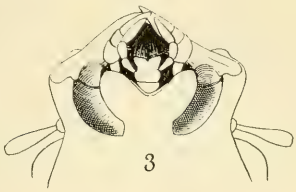
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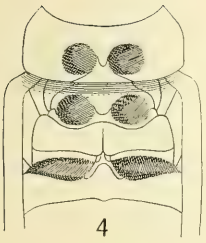
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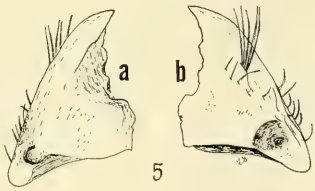

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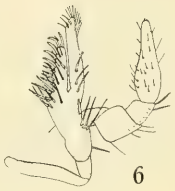
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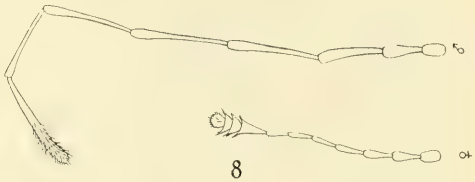
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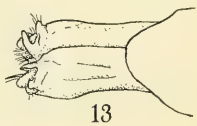
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NORTH AMERICAN PLATYSTOMOIDEA

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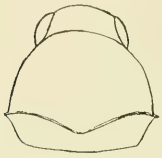
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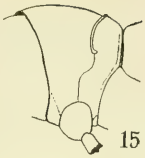
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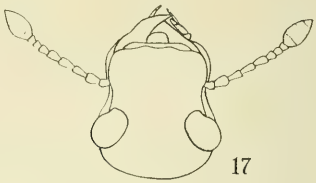
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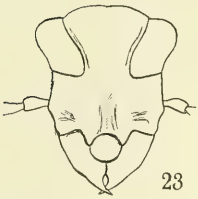
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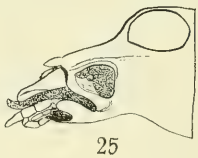
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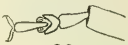
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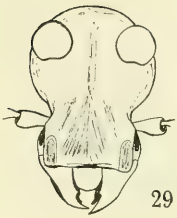
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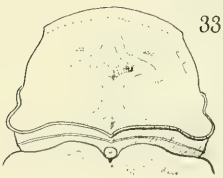
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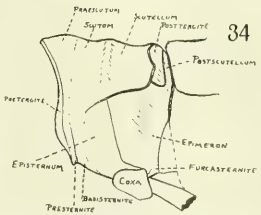

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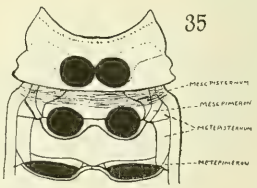

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NORTH AMERICAN PLATYSTOMOIDEA

FOR EXPLANATION OF PLATE SEE PAGE 33.

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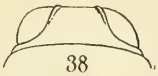
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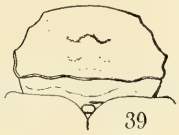
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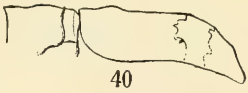
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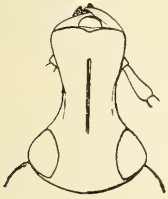
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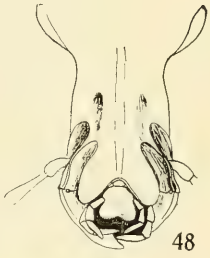
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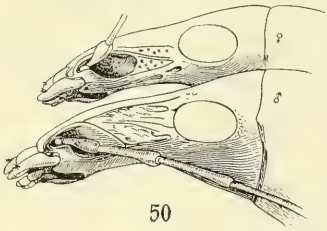
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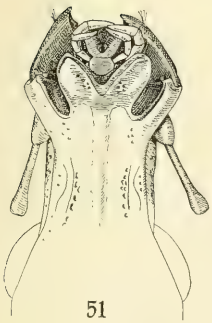
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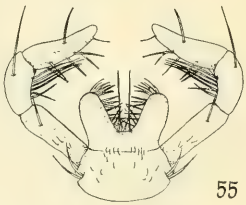
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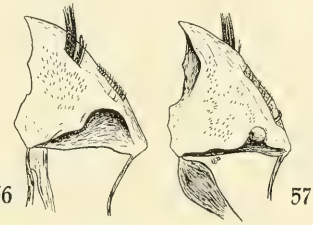
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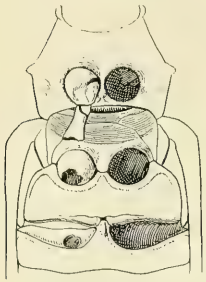
NORTH AMERICAN PLATYSTOMOIDEA

FOR EXPLANATION OF PLATE SEE PAGE 34.



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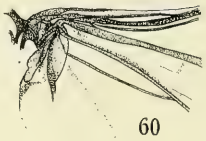

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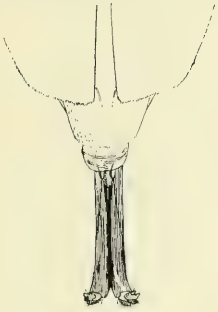

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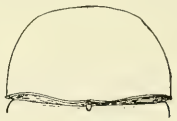

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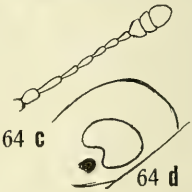

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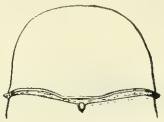

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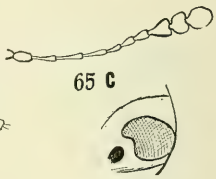

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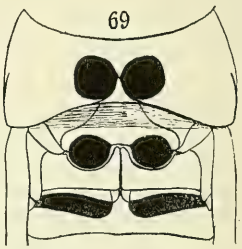

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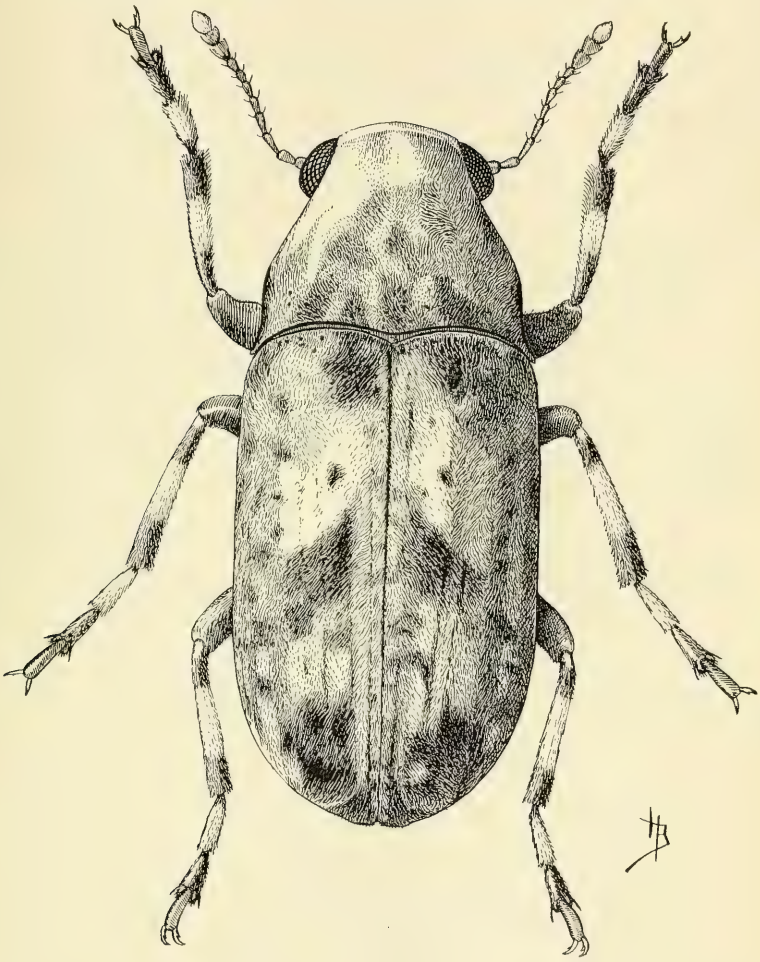
NORTH AMERICAN PLATYSTOMOIDEA

FOR EXPLANATION OF PLATE SEE PAGE 34.



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NORTH AMERICAN PLATYSTOMOIDEA

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NEW SPECIES OF NORTH AMERICAN WEEVILS OF THE GENUS LIXUS

By F. H. Chittenden

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The study of several collections of the curculionid genus *Lixus* inhabiting America north of Mexico resulted in finding several species which the writer considers new to science, and also a few variants, all of which will be described.

It has not been possible for the writer to secure the loan of Blatchley's types of *lupinus*, *morulus*, and *cavicollis*, as they are all unique, but that author very kindly furnished a specimen of his *leptosomus*. *L. crassulus* Notman is also unique, and Fall's *peninsularis* has not been seen, although specimens of his *bischoffi*, *perlongus*, and *maritimus* were available.

In the studies relative to this paper the writer has enjoyed access to the collection of the United States National Museum, including the Casey collection containing Casey's types and other valuable material; the collections of the Philadelphia Academy of Natural Sciences, the National Museum of Canada, the Illinois State Natural History Survey, the University of Kansas, and the Colorado State Agricultural College; and the collections of Messrs. L. L. Buchanan, F. S. Carr, D. K. Duncan, Warren Knaus, and H. P. Löding. Valuable material was furnished also by C. A. Frost, M. H. Hatch, E. C. Van Dyke, and J. B. Wallis.

It is a matter of common knowledge that the secondary sexual characters are vested in the rostrum: 1, that of the female being longer and usually more arcuate, and that of the male being both shorter and thicker; 2, that of the female being usually more shining black, and that of the male being more or less covered with pubescence. This is noticeable in such species as *fimbriolatus*, *perforatus*, *scrobicollis*, *mucidus*, *laramiensis*, and *pervestitus*. The place of in-

[1] Doctor Chittenden died on September 15, 1929. A short biographical sketch by Dr. L. O. Howard was published in the Journal of Economic Entomology, vol. 22, No. 6, 1929, pp. 989–990.

sertion of the antenna, as in the case of genera having long rostra, is nearly always nearer the apex in the male than in the female, but in small lots of a given species this character is difficult of observation, mainly because of imperfect mounting which does not show the point of insertion clearly.

The first abdominal segment is usually more or less distinctly convex in most females, but quite frequently is flat, or nearly so, as in the males. In the male of *concavus* this segment bears a distinct median elongate concave impression. In few other species is such a difference discernible; and the only apparent differentiation in certain small species, *marginatus* for example, is to be looked for in the rostrum and antennal insertion. In some females of this species the first ventral segment is feebly convex, and in some nearly flat or even feebly impressed. The sexual characters which have been mentioned are for the most part comparative, the exceptions being the presence of distinct abdominal impressions and the point of insertion of the antennae.

It naturally follows from what has been said that because of the extreme variations it is frequently a very difficult matter to describe adequately many species, as well as to indicate the sex in those species where only one or two examples are available.

The species are mostly of medium or large size; a few are small. Many are covered naturally with a dense vestiture, squamulose, scaly, or hairy on the disk of the elytra, but becoming longer, denser, more hairy, and paler or yellow at the sides, and frequently forming distinct lateral bands or vittae, especially on the prothorax. The pollinose coating of fresh specimens, varying in color from yellowish to red, is a form of this vestiture which is occasionally but not usually persistent in specimens that have been properly treated. In the case of the larger species, the chitinous structure is of such firm consistence that it is difficult to impale specimens by means of an ordinary insect pin.

DESCRIPTIONS OF NEW SPECIES

LIXUS ALBISETIGER, new species

Elongate cylindrical, four times as long as wide, moderately compressed, black, antennae, tibiae and tarsi red; vestiture extremely fine, gray, very short, moderately dense on sides of elytra but not forming vittae. Head finely punctate, especially at vertex, interocular fovea small. Rostrum of female fully as long as the pronotum, slender, evenly cylindrical, distinctly, evenly arcuate; surface nearly covered with fine hair-like scales, punctation fine, distinct and very dense throughout, somewhat coarser at the sides. Second funicular joint equal to or slightly longer than first, not so

long as third plus fourth. Prothorax distinctly wider than long, moderately arcuate at the sides, rather strongly tubulate at apex, where it is slightly wider than the head; base truncate, depression at middle shallow; surface with rather large shallow subvariolate punctures, very sparsely irregularly set; interspaces distinctly, finely, and closely punctulate. Elytra not wider at base than pronotum, sides parallel, strial punctures moderate in size, not closely set, first two striae rather feebly depressed at base, fourth and fifth also feebly depressed; vestiture rather feebly mottled.

All tibiae finely, not very distinctly serrulate on the inner margin.

Male.—Rostrum shorter than the pronotum, also thicker than in the female. First ventral segment rather widely, distinctly but not deeply depressed at the middle.

Length, 8–9 mm.; width, 2.2–2.8 mm.

Type locality.—Brownsville, Tex., November 19, 1911. Two examples.

Type.—Female, in the Illinois State Natural History Survey at Urbana, Ill. Allotype, male, Cat. No. 29030, U.S.N.M.

Nearly related to *marginatus* Say, differing notably by the slenderer, more distinctly arcuate rostrum with its much finer and denser punctation, and by the wider and more distinctly tubulate pronotum on which its larger punctures as well as punctules are comparatively indistinct. The male is not so strongly marked as the female type, the outline of the pronotum being less tubular anteriorly, while the elytra at the base are just perceptibly wider with fine acute angles. On the male rostrum there is also a faint line running from the interocular to the interantennal fovea showing a slight tendency to the development of a carina, which is probably never present.

LIXUS ASPERICOLLIS, new species

Comparatively robust, a little more than twice as long as wide; black, strongly shining, somewhat strongly depressed, vestiture mostly fine gray and very sparse. Head finely punctate, fovea small but distinct, in front of which there is a distinct fine carina scarcely extending to the apex of the scrobes. Rostrum nearly as long as the prothorax, thick, less than three times as long as wide, moderately arcuate, of nearly uniform dimensions, although a little wider near the apex from the dorsal view; scrobes extending fully two-thirds from base to apex; surface at base very strongly and coarsely punctate on sides, a little finer on anterior face. Antennae dark reddish, sparsely covered with rather coarse, short gray hairs; club densely covered as usual; first and second funicular joints subequal in length and width, each shorter than the succeeding two combined. Prothorax short, distinctly wider at base than long, narrowed an-

teriorly, gently arcuate in basal half, more strongly so towards apex; surface depressed, rather strongly impressed at middle fourth; sculpture of disk as well as of sides, extremely rough and irregular, punctures large, subvariolate, irregular and sparse, finely punctulate at apex; lateral vittae feebly indicated. Elytra less than twice as long as wide, a little wider than prothorax at base; humeral angles obtusely rounded; sides subparallel to apical one-third; extreme apices nearly closed. Third interval strongly elevated at base, inclosing a comparatively long and deep impression; intervals minutely punctulate; strial punctures small, more or less rounded, closely placed in regular rows; vestiture sparse, composed of short, gray, hair-like scales, moderately mottled, denser at apex and without definite lateral vittae. Ventral segments sparsely clothed with very long, fine gray hairs, not areolated. First and second segments narrowly impressed. Legs with short gray hairs; anterior femora strongly clavate.

Length, 10–11.5 mm.; width, 3.4–4 mm.

Type locality.—Garden City, Kans., September 23, 1913 (C. H. Popenoe).

Other locality.—Douglass County, Kans., 900 feet elevation (F. H. Snow).

Type.—Female, Cat. No. 29023, U.S.N.M. Paratype in the Illinois State Natural History Survey Collection, Urbana, Ill.

This species bears little resemblance to any other than *musculus* Say, being of similar size. It is a comparatively robust form and unusually depressed. The distinct carina, rough and coarse pronotal sculpture, with medium impression, and deeply concave postscutellar impression are among the distinctive characteristics. The paratype is less robust, with much shorter frontal carina, shorter pronotal impression, denser vestiture and smaller strial elytral punctures, and indistinctly subvariolate pronotal punctures.

LIXUS COLORADENSIS, new species

Elongate cylindrical, nearly four times as long as wide; black, coated with dense plumbeous vestiture, composed of minute yellowish gray squamules and longer hairs, mixed with reddish and yellowish, especially on prothorax and head. Rostrum cylindrical, as long as prothorax, distinctly arcuate, a little wider at base, very gradually narrowing to apex, not carinate, finely densely punctate, more coarsely between the eyes, punctation nearly concealed by long reddish yellow hairs. Eyes imperfect reniform, widest near the middle. Interocular fovea small. Antennae inserted less than three-fifths from the base; second funicular joint subequal to first but shorter than third and fourth together. Prothorax a little wider than long,

feebly arcuate at the sides, narrowly impressed at the middle and in the basal half, more deeply at the base; disk coarsely sparsely punctate, with closely-set fine punctules in the intervals, surface of disk moderately irregular, with dense yellowish red hairs in the impression and at the sides, not forming lines. Elytra at base slightly narrower than prothorax, humeri obsolete, sides subparallel in anterior three-fourths, distinctly narrowed at the middle, widening again in apical half, apices not divergent, disk flattened at middle, lightly impressed near the base, but distinctly impressed at the base of the third, fourth, and fifth striae; strial punctures small, moderately closely-set, of irregular shape, not rounded. Vestiture composed of a dense coating of extremely fine, short, gray squamules with slight reddish and yellowish hues, not mottled, not forming longitudinal lines, punctation largely concealed by the vestiture. Ventral surface with longer parallel gray hairs.

Female.—First ventral segment convex.

Length, 8.5 mm.; width, 2.2 mm.

Type locality.—Colorado. One specimen.

Type.—Female, Cat. No. 28822, U.S.N.M.

This appears to be a distinctive species with perhaps some relationship to *concavus* Say, the rostrum of the female resembling the latter in structure, although it is proportionately not so long and more nearly perfectly cylindrical. A striking character is the narrowed or slightly constricted middle of the elytra, possibly individual.

LIXUS PERSTRIATUS, new species

Elongate cylindrical, three and a half times as long as wide, moderately shining black throughout; vestiture of prothorax white at sides, composed of long pendant hairs, elytra with wide lateral vitta, and narrow sutural and discal and sublateral vittae, composed of silvery gray hairs. Head finely punctulate throughout, intermixed with very large coarse punctures extending from the occiput and encroaching far on the rostrum; fovea large, rounded. Rostrum in the female robust, about three and a half times as long as wide, feebly arcuate, of nearly uniform diameter; surface very finely punctulate, a few small punctures near the base and larger ones at the sides. First and second funicular joints subequal in length, first only a little wider than second, second not so long as third plus fourth. Pronotum nearly as long as wide, subquadrate, tubulate at apex; surface rather narrowly impressed at the middle in basal half, very deeply, coarsely and very irregularly variolate-punctate, punctures closely set, gradually increasing in size toward the base; apex and interspaces finely punctulate. Elytra about two and one-third times as long as wide, scarcely wider at base than the pronotum, but distinctly wider at humeri; sides parallel, suddenly narrowed toward the apex; extreme

apices nearly closed; disk flattened at base, scarcely depressed in postscutellar region, strongly impressed at sides. Vestiture of fine, silvery gray hairs, in basal half moderately short, in apical half, especially toward apex, longer, vittae more clearly defined. Intervals vittate as follows: Sutural, third, fourth (not strongly defined), and last lateral four, these latter practically separated by one or more rows of strial punctures; strial punctures larger, deep, quadrate, closely placed in rows, first and second rows close together with punctures more closely set than those of the other striae. Lower surface thickly coated with long gray and yellow hairs with longer tufts at the sides, not distinctly ocellate. Anterior femora rather strongly clavate, all femora densely clothed with long silvery gray hairs. Anterior tibiae not serrulate.

Female.—Rostrum nearly as long as the pronotum, not at all carinate.

Male.—Rostrum shorter and much thicker, about two and a half times as long as wide, more or less carinate from the frontal to the infra-antennal fovea.

Length, 7–9 mm.; width, 2–2.3 mm.

Type locality.—Cortez, Colo., June 19, 1925.

Type.—Female, Cat. No. 29037, U.S.N.M. Type, allotype, and paratype. Three paratypes in the collection of the State Agricultural College at Fort Collins, Colo.

Quite distinctive, bearing no resemblance to any other species in our fauna. The general appearance as viewed from above is more like *Cleonus* than *Lixus* since the elytra are decidedly striate-vittate, much more strongly than in *ivae*, new species. The punctation of the head and base of the rostrum, and especially that of the pronotum and elytra, is unique. The short thick rostrum is unlike that of *scrobicollis* Boheman and the fact that the short carina is distinct only in the male is unusual also.

LIXUS ACIROSTRIS, new species

Elongate cylindrical, nearly four times as long as wide, black, antennae dark brown, rostrum polished black; vestiture consisting of sparse minute silvery gray scales on dorsum; prothorax and elytra with distinct but inconspicuous, rather narrow lateral vittae of longer pubescence covering, although not concealing, the punctation of the last four intervals. Rostrum in the female fully as long as prothorax (as viewed from the side), continuous with the head, extremely slender, subcylindrical, very feebly arcuate, slightly bent backward at the middle where it is also distinctly widened at the sides, subcarinate in basal half; surface finely punctate in apical half, distinctly sparsely punctate in lines beginning with the head

and extending to the middle. Pronotum about as wide as long, arcuate at sides, not quadrate, subtubulate at apex; disk convex, flattened and feebly impressed in antescutellar region, deeply remotely punctate. Elytra about two and a half times as long as wide, at base little wider than pronotum, widening at humeri, thence parallel for two-thirds their length, suddenly, strongly narrowed to apex, extreme apices nearly closed. Disk distinctly, not deeply impressed in scutellar region, impression wider than long, including three intervals each side, humeral impression also distinct, narrow; strial punctures rather small and deep, remotely placed, arranged in subregular rows in type specimen, but distinctly confused in outer basal half of elytra in paratype; vestiture not mottled. First ventral segment convex, unimpressed, second very long, distinctly longer than third and fourth combined; surface sparsely punctate, vestiture whitish, moderately long, subocellate, forming a triangular yellow tuft each side of fifth segment. Legs long, slender, with sparse pubescence.

Length, 6–8.4 mm.; width, 1.4–2.7 mm.

Type locality.—Black Mountains, N. C., June 24, 1912 (W. Beutenmuller).

Type.—Female, Cat. No. 29022, U.S.N.M. Paratype (Black Mountains, N. C., June, 1902, E. C. Van Dyke) in collection of Doctor Van Dyke, University of California.

The male is unknown. This species is distinctive in the *sylvius* group. It is of similar form and closely related to *sylvius* Boheman but distinctly slenderer, with much slenderer female rostrum, the apex of which is nearly impunctate rather than distinctly punctulate, the lateral elytral vitta is somewhat narrower and the elytral punctation is not so coarse nor so deep. In *sylvius* Boheman the elytra, in perfect specimens, may have broad vittae or be entirely mottled, and the rostrum in both sexes is sparsely pubescent.

LIXUS ORDINATIPENNIS, new species

Elongate subcylindrical, about three and one-third times as long as wide, black, antennae dark brown; vestiture consisting of short, fine, scale-like hairs, sparse on dorsum of elytra, denser at middle of pronotum; sides of prothorax and elytra with an inconspicuous narrow gray lateral vitta attaining the elytral apex. Rostrum in the female about as long as the pronotum, robust, three times as long as wide, subcylindrical, somewhat flattened anteriorly; rather feebly arcuate, widest near middle; comparatively coarsely and very sparsely punctate in basal portion and at sides, punctulate at apex below scrobes; entire surface covered with gray pubescence partially obscuring the sculpture. Second funicular joint shorter than third plus fourth. Prothorax nearly as wide as long, basal three-fourths

subparallel, narrowed but not tubulate anteriorly; flattened on disk, surface sparsely variolately punctate, punctures of nearly same size except at apex, where they are very small and rather widely separated; interspaces very finely densely punctulate; feebly impressed in antescutellar region, where the vestiture is longer. Elytra less than three times as wide as long, scarcely wider at base than pronotum, humeri not prominent, umbone not visible, sides parallel from humeri nearly three-fourths to apex, apices nearly closed at the ends; postscutellar impression very short, wider than long, moderate in depth, not extending at the sides beyond the second intervals; humeral impression obsolete, strial punctures small, rounded, moderately separated in very regular rows, both transversely as well as longitudinally, the transverse rows imparting a subrugose aspect to the exterior; disk vestiture mottled. Ventral segments finely sparsely punctate, with fine gray hair-like vestiture. Legs slender.

Length, 6 mm.; width, 1.8 mm.

Type locality.—Opelousas, La. (G. R. Pilate).

Type.—Female, Cat. No. 29031, U.S.N.M. A single specimen.

A distinctive species of the *sylvius* group, easily recognized by the remarkable regularity of the strial rows of elytral punctures. It is, moreover, the smallest and slenderest of this group. Other distinguishing characters are the short and narrow postscutellar impression, obsolete humeral impression and unusual rostrum.

LIXUS QUADRATIPUNCTATUS, new species

Elongate subcylindrical, a little more than three times as long as wide, sides parallel, convex, pronotum distinctly flat, plumbeous, antennae red, vestiture gray, moderately coarse on the head, sides and middle of prothorax and sides of elytra with long hairs coated with yellow; elytra with last four intervals covered with a gray vitta that more or less conceals the punctation. Head finely punctate on vertex, coarsely, somewhat sparsely punctate between the eyes; fovea small. Rostrum not quite so long as the pronotum, very feebly arcuate, coarsely sparsely punctate at base, feebly punctulate at apex. First funicular joint subequal to second, second shorter than third plus fourth. Pronotum subquadrate, tubulate at apex; feebly irregularly depressed at middle, depression wider at base; surface irregularly subvariolately punctate. Elytra distinctly although only slightly wider at base than pronotum, humeri not prominent, umbone obsolete, sides parallel in basal three-fourths, widest a little posterior to the middle, narrowing in apical fourth, apices nearly closed, postscutellar impression short, humeral impression wide and deep; strial punctures coarse, dense; vestiture short and fine. Ventral surface with dense very long gray hair. Femora slender.

Length, 5.8 mm.; width, 1.8 mm.

Type locality.—Colorado Springs, Colo., 6,000–7,000 feet, June 15–30, 1896 (H. F. Wickham).

Type.—Cat. No. 29024, U.S.N.M. Sex indeterminate. Unique.

The species is moderately distinctive by reason of the peculiar coarse punctation of the rostrum, the irregularly variolate-punctate pronotum, and the dull gray or plumbeous color. It belongs in the *sylvius* group.

LIXUS SYLVIUS PROFUNDUS, new variety

Elongate cylindrical, nearly four times as long as wide, polished black, mostly glabrous with very sparse vestiture. Head with round interocular fovea, surface at base distinctly, very irregularly punctate and finely densely punctulate. Rostrum in the female longer than pronotum (as viewed from the side), more slender than in normal *sylvius* Boheman but not so slender as in *acirostris*, new species, very feebly arcuate. Pronotal impression distinct, extending from base nearly to apex, punctures very irregular. Elytra with prominent umbone, striae strongly deeply punctate. Vestiture sparse on ventral surface.

Male.—Rostrum a little shorter than pronotum, much more robust than in female, a little less than three times as long as wide, coarsely punctate in basal portion to interantennal fovea, from that point punctulate to apex. Entire surface still more coarsely punctate than in female. First ventural segment faintly and narrowly impressed at middle.

Length, 6.75–10 mm.; width, 2–3 mm.

Type locality.—St. Louis, Mo.

Other localities.—Washington, D. C. (F. H. Chittenden); Arlington, Va. (F. H. Chittenden); Georgia; Mobile, Ala. (H. P. Löding); Nashville, Tenn.; Texas; Lexington, Tex. (Birkman); San Saba River, Tex.

Type.—Female, in the Canadian National Collection, Ottawa, Canada. Allotype and nine paratypes, Cat. No. 29029, U.S.N.M. Paratypes in collections of Illinois Natural History Survey and of C. A. Frost.

It is evident that the specimens studied, 12 in number, are abraded and there is evidence that the lateral vittae of the elytra may be distinct in some specimens and wanting in others, as in normal *sylvius* Boheman.

LIXUS CRASSIPUNCTATUS, new species

Elongate cylindrical, about four times as long as wide, moderately depressed, black, feebly shining, vestiture consisting of long gray hair-like scales forming a very broad lateral vitta from eyes to apex of elytra, somewhat concealing punctation of nearly half the elytral

striae; elytra also with a narrower median vitta. Head finely, densely punctate on occiput, fovea shallow, very coarsely and densely punctate between the eyes. Rostrum in the male much shorter than pronotum, very feebly arcuate, distinctly carinate in more than half its length; surface very coarsely punctate in basal two-thirds, apical third punctulate, an interantennal fovea indicated at end of carina. First funicular joint wide and short, second longer and slenderer, not so long as third and fourth together. Pronotum scarcely longer than wide, basal two-thirds subparallel, apex faintly tubular; surface irregularly and deeply variolately punctate, punctures small at apex, concealed by vestiture at sides; interspaces punctulate; widely but not deeply impressed in antescutellar region. Elytra narrow, especially at extreme base; humeral umbonal process prominent, shining; basal three-fourths of sides subparallel; apices closed; postscutellar impression moderate in width and depth; a small rather deep impression above each umbone. Punctation of discal striae very coarse and moderately irregular in closely set rows; punctures very irregular in shape and size, mostly rounded, but some in basal portion of disk oval and elongate oval; the first row most densely punctate and the second and third striae containing elongate oval punctures. Ventral surface sparsely punctate, punctures quite visible because of sparse vestiture, first segment nearly flat, second convex, third, fourth, and fifth widely separated, fifth transversely moderately depressed at middle. Legs of moderate length, not very strongly clavate.

Length, 9 mm.; width, 2.3 mm.; rostrum, 1.5 mm.

Type locality.—Santa Rita Mountains, Ariz., 5,000–8,000 feet, July (F. H. Snow).

Type.—Male, in University of Kansas Museum, Lawrence, Kans. Unique.

This species resembles the male of *scrobicollis* Boheman, from which it may be distinguished readily by the much coarser punctation of the rostrum and elytra. The pronotal punctation is finer and more sparse. The humeral umbone is more prominent, the vittae are broader and different, and the rostrum is distinctly carinate.

LIXUS IVAE, new species

Elongate oval, cylindrical, about four times as long as wide, entirely black; vestiture gray, long, fine and hair-like on sides of prothorax and on legs; lateral elytral vittae covering, but not concealing, the punctation of the last five elytral intervals. Head punctulate just in front of occiput, then coarsely densely punctate, punctation extending far between and under the eyes on the rostrum, largely concealed by vestiture. Male rostrum nearly one-fourth shorter than pronotum, less than three times as long as wide, distinctly

flattened on the anterior face, punctulate at apex, punctation much obscured by vestiture. First funicular joint wide, little longer than wide, second distinctly longer but not longer than third and fourth together. Pronotum as wide as long, moderately depressed, sides for two-thirds their length parallel, anterior third narrowed to apex. Antescutellar impression about one-fourth the length of the pronotum, narrow, of moderate depth; surface coarsely irregularly and deeply, variolately punctate, vestiture at middle fine and hair-like. Elytra more than twice as long as wide, slightly wider at base than pronotum; humeral umbone not prominent; postscutellar impression shallow, nearly flat, wider than long; sides from humeri two-thirds toward apex nearly parallel, apices nearly closed; vestiture fine, dull gray, third and fifth intervals each with a vitta of long gray squamules with lateral transverse branches, the effect being strongly vittate; strial punctures of moderate size, deep, comparatively sparsely placed, the spaces between variable but averaging less than the diameter of one puncture. Legs rather slender, except anterior femora which are strongly clavate.

Length, 5.5–8.4 mm.; width, 1.4–2.2 mm.

Type locality.—Baton Rouge, La., August 17, 1909. Reared from stem of *Iva ciliata* (Hunter No. 219).

Other locality.—Torras, La.

Type.—Male, Cat. No. 29033, U.S.N.M. Type and three paratypes.

Female.—Rostrum a little shorter than the pronotum and about one-fourth longer but scarcely more slender than male.

The species is fairly distinctive by the unusual arrangement of the elytral vestiture, causing a beautifully striped effect. It is apparently most closely related to *scrobicollis* Boheman. The smallest measurement applies to a specimen that is immature and obviously depauperated, from Torras, La. It has been reared also from stem of *Ambrosia* species.

LIXUS DISSIMILIS, new species

Elongate oval, less than three times as long as wide; subcylindrical, black, joints of antennae dark rufous. Vestiture dense gray with broad vitta on flanks of prothorax and with or without a broad sublateral vitta on each elytron. Head with large irregularly-shaped shallow fovea, punctures coarse in undulating rows. Rostrum in the male short, about three times as long as wide, thick, distinctly arcuate, slightly bent backward below middle, coarsely punctate in undulating rows to apical third where punctation is finer. Prothorax and elytra very similar to *scrobicollis* Boheman but the strial punctures are larger and more closely set and the basal ones are either quadrate or nearly so.

Length, 7–9 mm.; width, 2.2–3.4 mm.

Type locality.—Barnesville, Ga., August 11, 1927 (T. L. Bissell).

Type.—Male, Cat. No. 29034, U.S.N.M. Type and paratype.

Resembles *scrobicollis* Boheman and is closely related to that species. It is shorter, has a distinctly arcuate and backward bent rostrum and the strial punctures at the base are larger, more closely set and quadrate. The two specimens differ in a few respects, the smaller one having smaller strial punctures with the pronotum narrowed just before the base.

LIXUS TRICRISTATUS, new species

Elongate cylindrical, nearly four times as long as wide. Black, feebly shining, dorsum with dull plumbeous effect; vestiture fine, forming a wide gray lateral vitta on elytra and prothorax; elytral vitta pale whitish gray; antennae dark reddish brown, legs black. Head moderately coarsely and deeply punctate; fovea rounded and deep. Rostrum in the female a little shorter than the prothorax, thick, distinctly arcuate, somewhat coarsely, deeply and densely punctate at base, finely in apical third, finely subcarinate in basal half. Scrobes not extending to apical third. First funicular joint very wide, about one-fourth longer than wide; second slightly longer but more slender, scarcely wider than third and fourth, which combined equal it in length. Prothorax short, distinctly wider than long, subconical; basal half subparallel; punctures moderate sized and fairly densely placed, interspaces very finely, irregularly punctulate, a very short rather deep impression at middle just before the scutellum; vestiture fine, long, depressed, extending irregularly backward toward the base, a short median line at apex extending one-third toward the base, each side of which there is an incurved line directed toward the sides; at the sides a wide vitta of yellowish gray thicker hairs. Elytra about four-ninths as wide as long, wider than prothorax at base; humeri not prominent, umbone hardly visible; sides subparallel in basal two-thirds, apices scarcely separate; punctures rather small and deep in rows, vestiture very short and fine, lightly mottled, a vitta of longer, lighter gray squamules covering the outer four intervals. Ventral surface with longer hairs, dense, partly concealing the fine surface punctulation. Inner margin of anterior tibiae distinctly serrulate.

Rostrum in the female longer than in the male. First ventral segment in the female feebly convex; third, fourth, and fifth segments strongly separated.

Rostrum in the male notably shorter and thicker. First ventral segment broadly but feebly impressed at middle.

Length, 7.2–10.4 mm.; width, 2–2.8 mm.

Type locality.—Iowa City, Iowa, April 23, 1895 (H. F. Wickham).

Other localities.—Elliott, Iowa (H. F. Wickham); Ames, Iowa (D. Stoner); Onaga, Kans.; Mountain Grove, Mo. (J. L. Horsfall); Carlisle, Ark. (Stromberg collection); New York City, N. Y. (C. H. Roberts); Riverdale, Md. (Mrs. D. H. Blake); Washington, D. C. (F. H. Chittenden); Rosslyn, Va. (F. H. Chittenden); Delchamps, Ala.; Rosedale, Miss. (H. L. Sutherland); Baton Rouge, La. (T. H. Jones).

Type.—Female, Cat. No. 29021, U.S.N.M. Type, allotype and eight paratypes. Paratypes also in collection of Illinois State Natural History Survey, Canadian National Collection, University of Kansas, and in the private collections of F. S. Carr, Warren Knaus, and H. P. Löding.

Mrs. D. H. Blake observed the beetle ovipositing on *Bidens* species at Riverdale, Md.

This species differs from *scrobicollis* Boheman, with which it has been mixed in collections, in the relatively more slender rostrum of the male, noticeably finer pronotal punctation and the three lines of hairs at the apex, unfortunately likely to be worn off. The lateral elytral vittae are also usually and normally pronounced. The inner margin of the anterior tibiae are strongly serrulate, but not, or very feebly so, in *scrobicollis* Boheman.[2] The male rostrum, in many specimens, is remarkably short and thick. The rostral carina is sometimes wanting as is also the prothoracic median line. In some examples there is also an interantennal fovea. In the series studied the prothoracic vestiture does not extend in divergent pale lines each side of the disk as in well-marked *scrobicollis* Boheman. Fresh specimens show some reddish pollinose coating.

The shape of the rostrum varies moderately in the female, one being longer than the pronotum, but in the male it is quite variable from gently arcuate to a blunt form resembling *musculus* Say male in miniature. The punctation of the male rostrum is very similar in the two species.

LIXUS PLANICOLLIS, new species

Elongate subcylindrical, rather feebly depressed, a little less than four times as long as wide; black with plumbeous effect; vestiture fine gray, very short except at sides of prothorax and on legs; no lateral vittae, antennae and tarsi red. Head rather indistinctly punctate, fovea distinct. Rostrum in the male nearly one-fourth shorter than the prothorax, not quite three times so long as wide, nearly cylindrical, moderately arcuate, not distinctly carinate, cov-

[2] This character is found in some unrelated species, notably in *rubellus* Randall, *laramiensis* Casey, and in some specimens of *terminalis* LeConte.

ered with short vestiture, rather closely and irregularly punctate forming rows at sides, finer toward apex. Scrobes extending fully four-fifths from the base. First funicular joint a little shorter and wider than second, second subequal to third and fourth combined, third and following joints not very distinctly separated, club long. Prothorax nearly as long as wide, tubulate anteriorly, sides posteriorly subparallel; disk with shallow median impression; surface rather finely and densely, not variolately punctate, interspaces distinctly punctulate. Elytra distinctly wider at base than prothorax, anterior angles acute; base of outer two striae flat at sides forming a slight depression, which borders a slight tumidity at the sixth and seventh intervals; surface feebly rugose, strial punctures rather coarse, in regular rows; vestiture not mottled. First and second ventral segments nearly flat at the middle. Legs slender; anterior tibiae finely serrulate on the inner edge.

Length, 7–8 mm.; width, 1.9–2.2 mm.

Type locality.—Iowa City, Iowa, October 7, 1916 (R. Whittle).

Other locality.—New Orleans, La. (H. Soltau).

Type.—Male, Cat. No. 29028, U.S.N.M. Two males, type and a paratype.

Moderately distinctive, differing from *tricristatus*, new species, by the much shorter and slenderer rostrum, which with the head is more coarsely and densely punctate. The ante-scutellar impression is negligible. The female is unknown.

LIXUS PERVESTITUS, new species

Moderately elongate subcylindrical, three times as long as wide; opaque black, surface except rostrum, and antennae with fine, short, cinereous pubescence, over which is a longer yellow pollen-like coating, much obscuring the punctation. Rostrum shining black, approximately as long as the prothorax, slender, somewhat feebly subequally arcuate, slightly bent downward in front of scrobes, with or without a fine carina from head to interantennal fovea; interocular fovea wanting; head with comparatively very large subvariolate punctures, similiarly punctulate on intervals between as on prothorax, punctures continuing on rostrum in the basal half much finer, distantly irregularly placed; on the apical two-fifths, finely punctulate. Antennal scape dark red, remainder covered with gray pubescence, first and second funicular joints subequal in length, latter shorter than third and fourth together. Prothorax a little longer than wide, subconical, widely and moderately deeply impressed in the basal half, or more or less throughout its length, feebly arcuate at sides; surface of disk very coarsely variolately and sparsely punctate, intervals between punctures minutely punctulate, the yellow vestiture at sides diverging from the apex toward the base, becoming felted at the sides.

Elytra much wider at base than prothorax, humeri gradually obtusely rounded, rather prominent; sides subparallel in basal three-fourths, apical fourth narrowed, apices scarcely separated. Third intervals strongly elevated for a short distance at base, the two somewhat convergent ridges thus formed enclosing the subdeltoid, nearly flat post scutellar impression; between the ridge on third interval and the feeble humeral umbone is another smaller impression; discal punctures coarse, somewhat irregularly and rather closely placed, largely obscured by coating; vestiture not forming stripes and not mottled. Ventral surface nearly flat, with much longer hairy pubescence; sculpture of large, shallow, rounded punctures, distantly placed. Legs large, with similar coating to body.

Female.—Rostrum about the same length as the prothorax, subequally arcuate. Antennae inserted slightly beyond the middle.

Male.—Rostrum a little shorter than the prothorax, thicker, about three times as long as wide. Antennae inserted nearly three-fifths from the base.

Length, 9.5–11 mm.; width, 2.8–3.6 mm.

Type locality.—Phoenix, Ariz. (D. K. Duncan).

Other localities.—Roosevelt Lake, Rice, Florence, and Bill Williams Fork, Ariz.; Las Cruces, N. Mex.

Type.—Female, Cat. No. 29025, U.S.N.M. Type, allotype, and eighth paratypes in National Museum. Paratypes in the collections of the Canadian National Museum, Philadelphia Academy, Kansas University, Colorado Agricultural College, Illinois State Natural History Survey, and in the private collections of F. S. Carr, D. K. Duncan, C. A. Frost, Warren Knaus, H. P. Löding, and J. B. Wallis.

Somewhat closely related to *perforatus* LeConte but considerably larger and more robust, and nearly completely covered with a thick pollinose coating. The rostrum is proportionately longer and more distinctly depressed. There is no visible lateral elytral stripe as in fresh specimens of that species. The punctures on the head are smaller, not so closely set, therefore do not generally tend to coalesce and form grooves, and the punctures on the upper half of the rostrum are also smaller. The punctures on the pronotal disk and on the elytra are smaller and shallower. On the pronotum of *pervestitus* the intervals might be described as alutaceous. In both species the pronotum may be either moderately sulcate as in the type or impressed by a narrow line.

LIXUS FLEXIPENNIS, new species

Elongate subcylindrical, somewhat strongly depressed, a little less than four times as long as wide. Black, strongly shining; vestiture fine gray, not forming lateral stripes; rostrum, disk of prothorax, and anterior half of elytra at middle highly polished glabrous or

subglabrous black. Head finely distinctly punctate; interocular fovea well defined, oblong. Rostrum about as long as the prothorax, slender, feebly arcuate, at base and on head between eyes strongly punctate in longitudinally impressed rows, more finely punctate toward apex. Scrobes scarcely extending three-fifths from the base. Antennae reddish, long and slender. First funicular joint short and moderately wide; second very narrow and slender, nearly one-third longer than first and longer than the two succeeding joints together. Prothorax about as wide as long, feebly tubulate at apex, feebly arcuate at sides, widest just behind the middle; disk somewhat deeply impressed at middle in posterior half, surface moderately deeply, variolately punctate, punctures irregularly set, interspersed with fine punctules, closely set, and some sparse vestiture toward base; sides with longer irregular vestiture. Elytra three times as long as wide, humeral angles prominent but not tumid, sides subparallel in apical three-fifths; base of first two intervals rather flat, scarcely impressed, extreme apices very slightly everted; strial punctures rounded in fairly regular rows; vestiture scant anteriorly, dense toward apex, mottled. Ventral surface moderately hairy, denser at posterior extremes of each segment, last segment still denser. Legs slender; first pair of femora distinctly clavate.

Female.—Rostrum as described. First and second abdominal segments with a somewhat deep median impression.

Length, 9.7 mm.; width, 2.6 mm.

Type locality.—Lake Okoboji, Iowa, July 6, 1917 (L. L. Buchanan).

Type.—Female, Cat. No. 29027, U.S.N.M. Unique.

This species looks more slender than the measurements indicate. Some of the more salient characters include, besides the slenderness, the strongly depressed body, polished black color, sparse vestiture, and long slender rostrum with impressed rows of punctures at base, flat rather than impressed scutellar portion of elytra, and the long ventral impression of the female. The antennal structure indicates some affiliation with *julichi* Casey, from which it differs by many characters, more especially by the prominent humeral angles not being distinctly tumid. It is, moreover, much slenderer and has much less vestiture than that species.

LIXUS BUCHANANI, new species

Elongate cylindrical, nearly four times as long as wide, black, shining; vestiture gray, sparse, with broad lateral vitta on prothorax only. Elytra strongly mottled with gray. Rostrum slender, distinctly longer than pronotum, cylindrical, moderately arcuate, not at all carinate; surface finely, strongly, sparsely punctulate throughout. Head a little more coarsely punctulate; interocular fovea small. Antennae dark piceous, inserted a little posteriorly from the middle.

First funicular joint at apex wider than second; second about one-fourth longer, slender but at apex as wide as third, about as long as third, fourth, and fifth together. Pronotum only a little wider than long, feebly arcuate at sides; antescutellar impression moderately shallow, without median impressed line; disk rather feebly and indistinctly variolately punctate, punctures small, irregularly placed, scarcely evident anteriorly; interspaces densely and distinctly punctulate. Elytra scarcely wider than pronotum, three times as long as wide, sides parallel in basal two-thirds; postscutellar region nearly flat; humeral angles scarcely visible; surface with quite regular rows of fine rounded punctures. Legs long, moderately slender; femora somewhat strongly clavate; anterior tibiae strongly serrate on inner margin; surface of legs coated with fine, short, gray hair-like scales. Vestiture of abdominal segments dense.

Length, 10.5 mm.; width, 2.7 mm.; rostrum, 3 mm.

Type locality.—Lake Okoboji, Iowa, July 6, 1917 (L. L. Buchanan).

Type.—Female, Cat. No. 29027, U.S.N.M. Unique.

A quite distinctive species named in honor of L. L. Buchanan. The size, and the length and shape of the rostrum, are suggestive of *sylvius* Boheman, from which it is separated readily by the pronotal punctation. Superficially it resembles *flexipennis*, new species, but it is wider and has a longer, more arcuate rostrum, with finely punctulate surface throughout its length. That the second funicular is as long as the third plus the fourth plus the fifth is remarkable.

LIXUS PLUCHEAE, new species

Elongate cylindrical, a little less than four times as long as wide, dark reddish brown, head and rostrum black, antennae a little lighter red than body, densely coated with fine dull ocherous-yellow pubescence. Rostrum shorter than prothorax, moderately thick, about three times as long as wide, rather feebly arcuate on anterior surface, nearly straight on posterior, obsoletely carinate basally, surface punctation partly obscured by vestiture, coarsely punctate between the eyes with a tendency to form grooves, punctures finer toward apex. Interocular fovea very small. Antennal scrobes beginning about one-third from apex; antennae inserted a little above that point or a little below the middle; first and second funicular joints subequal in length, second about as long as third and fourth together. Eyes comparatively small, ovate, wider toward apex. Prothorax about as wide as long; wide at apex, sides nearly straight; disk without sulcus and without asperities; deeply impressed at base in middle, especially deeply in scutellar region, narrower and more shallow apically; surface nearly smooth, coarsely, sparsely punctate; interspaces finely and densely punctulate; vestiture composed of long,

yellow hairs, sparse in impression, at sides very dense. Elytra at base not wider than prothorax; humeri scarcely visible; widest just behind base; sides subparallel in basal three-fourths; apices very slightly divergent; surface smooth, not rugose, rather feebly impressed at middle near base; discal punctures of moderate size, nearly round in outline, deep, remotely placed, closely-set at apex; vestiture composed of very minute ocher-yellow scales, lightly interspersed with paler squamules, producing feebly indicated mottling, not forming lateral or other stripes. Ventral surface with longer hairs, especially long on fifth ventral segment. Femora annulate.

Female rostrum a little shorter than the prothorax. First ventral segment flat at middle.

Male rostrum a little shorter than female. First ventral segment distinctly impressed at middle.

Length, 7–10 mm.; width, 1.8–3 mm.

Type locality.—Brownsville, Tex., July 22, 1923 (T. C. Barber).

Other locality.—Victoria, Tex. (J. D. Mitchell).

Type.—Female, Cat. No. 28800, U.S.N.M. Type, allotype, and four paratypes.

Mr. Mitchell found that the species breeds in the roots of *Pluchea camphorata* (Linnaeus) DC. or salt-marsh fleabane.

Closely related to *fossus* LeConte, a striking difference being in the dense ocher-yellow vestiture in contrast to the scant pale-gray pubescence of the latter. The rostrum is a little stouter and less arcuate and the elytra are smooth, not rugose as in normal *fossus* LeConte. The color appears to be constant, at least in the series of six specimens studied. The two species agree closely in dimensions. The comparative length of the rostrum is subject to variation.

LIXUS FOSSUS OCELLATUS, new variety

Form and general appearance similar to typical *fossus* LeConte. Head coarsely punctate in undulating groove-like rows; fovea small, rounded, distinct. Rostrum in the female shorter and a little thicker than in *fossus* LeConte, but nearly as long as the pronotum, somewhat flattened, distinctly arcuate, not distinctly carinate, punctures fine and very close with a tendency to form narrow longitudinal rows. Antennae inserted a little above the apical third of the rostrum. Eyes prominent. Vestiture very fine gray, covering somewhat lightly the entire body surface, including the rostrum in the male. Pronotum subconical, approximately as long as wide; antescutellar depression deeply, rather widely concave at base, forming an irregular somewhat rounded area; surface very minutely, very densely punctulate, also with coarser but comparatively fine punctures, variably, very sparsely placed. Ventral surface with long gray pubescence, ocellate at the sides of the first and second segments.

Female.—Rostrum as above described. First and second ventral segments feebly convex at the middle.

Male.—Rostrum a little shorter and thicker than in the female.

Length, 6.5–8 mm.; width 1.9–2.2 mm.

Type locality.—Coney Island, N. Y., June 18, 1887 (F. H. Chittenden).

Other localities.—New York City and vicinity (Wm. Jülich); Elizabeth, N. J. (H. F. Wickham); New Jersey.

Type.—Female, Cat. No. 29036, U.S.N.M. Type, allotype, and three paratypes.

The type is somewhat different from the paratypes. The rostrum is polished black and evidently for this reason appears more slender. The pronotum is abraded, thus showing the sculpture to advantage. Through the longer vestiture of the flanks of the prothorax, however, the surface is shown covered with fine punctures, sparsely set, minutely punctulate in the interspaces.

LIXUS CAPITATUS, new species

Slender, oblong, nearly four times as long as wide, very dark plumbeous with slight reddish tint, strongly convex on dorsum, lower surface somewhat flat. Rostrum nearly as long as prothorax, very thick, subcylindrical, not carinate but bearing a distinct median groove below middle two-fifths, interocular fovea small, distinct; surface moderately and irregularly punctate, in finely twisting grooves. Head large and prominent, punctulate. Antennae red; first funicular joint wide, second narrow and slender, subequal to third and fourth combined. Prothorax about as long as wide, distinctly wider at base than the elytra; surface rather coarsely but not variolately nor deeply punctate, punctures widely set with intervals between finely punctulate; rather deeply concave in basal half with a deep linear impression; vestiture composed of fine hairy squamules at sides. Elytra long, about three and one-half times as long as wide, no median impression at base, apices slightly divergent; surface deeply, moderately finely punctate, punctures oblong with tendency to form transversely parallel rows at base, first impressed at apex; vestiture finely squamulose. Legs long; tarsi pale. Vestiture of ventral surface moderately long, dark gray, not nucleated.

First and second ventral segments in the male longitudinally impressed at middle.

Length, 8 mm.; width, 2.5 mm.

Type locality.—Chevy Chase, Md., June 14, 1905 (F. H. Chittendon). Unique.

Type.—Male, Cat. No. 28799, U.S.N.M.

Taken from the stem of *Ambrosia trifida* Linnaeus with *L. scrobicollis* Boheman.

A distinctive species, evidently related to *sexualis* Casey but mainly differing by the much thicker rostrum, the absence of a definite median impression at the base of the elytra and the rather fine distinctly oblong punctures of the same. The subapical rostral fovea and the pronotal concavity with its deeply linear impression are also evidently constant and specific.

LIXUS LODINGI, new species

Moderately robust subcylindrical, black with dark reddish antennae; vestiture very fine, light gray. Rostrum in the female stout cylindrical, about as long as the prothorax, nearly straight, not at all carinate; surface finely densely punctate, in furrows at sides. Head densely, coarsely punctate in furrows between the eyes, interocular fovea rounded, deep. Antennal scrobes beginning about one-fourth from apex; first and second funicular joints long, second longer and slenderer but not quite so long as third, fourth, and fifth combined. Prothorax about as wide as long, not narrowed behind head, sides feebly arcuate, depressed in basal third, deeply so near base; disk somewhat depressed; surface in apical three-fourths nearly smooth without asperities, with comparatively small punctures, remotely placed, between which are very small punctules, closely set; surface well covered with long hairlike scales, a little denser and longer at the sides, forming a paler vitta. Elytra distinctly wider at base than prothroax, postscutellar and a humeral impression moderately deep; sides subparallel in middle half; apices separately and slightly rounded; surface moderately convex, striae with somewhat irregular rows of moderate sized, rather shallow, rounded punctures; vestiture dense, composed of very fine, short, dull gray hairlike squamules, mottled with many fine whitish gray spots; ventral surface with longer vestiture, on sides, legs and first and second abdominal segments distinctly ocellate.

Rostrum in the male shorter than in the female; first ventral segment feebly, distinctly impressed at middle.

Length, 10–10.5 mm.; width, 4 mm.

Type locality.—Mobile, Ala. (H. P. Löding).

Other localities.—Magazine Point, Ala.; Delchamps, Ala.; Tampa, Fla. (Hubbard and Schwarz); West Monroe, La. (Rehn and Hebard); Louisiana (Horn Collection).

Type.—Female, Cat. No. 28835, U.S.N.M. Type, allotype, and paratypes. Paratypes in the collections of the Philadelphia Academy and of H. P. Löding.

A comparatively distinctive form, not very closely related to any of the group with which it is placed. Next to *blakeae* Chittenden, it is the most robust species of the group. The rostrum is not dis-

tinctly arcuate, the pronotal disk is practically smooth, without asperities or variolate punctures and the antescutellar concavity is short and deep, much as in *julichi* Casey. The vestiture is not so noticeably mottled as in the latter and the ocellate character of the entire lower surface and sides is worthy of remark.

LIXUS REGULARIPENNIS, new species

Subcylindrical, about three times as long as wide, black throughout, moderately shining; surface densely covered with very fine, rather dark gray scalelike hairs, denser at sides, forming wide, not conspicuous lateral vittae. Surface of head coarsely and densely punctate, punctures rounded. Rostrum fully one-fourth shorter than the pronotum, cylindrical, robust, two and a half times as long as wide, rather feebly arcuate, finely carinate from the interocular fovea to the middle, where there is a longer interantennal fovea; apex narrowed as viewed from the side, subacuminate at the extremity, scrobes scarcely reaching to apical third. Surface from the base nearly to the middle closely and irregularly punctate, toward apex much finer and more regular, normally pubescent throughout, pubescence covering carina. Antennae with scape dark brown; first and second funicular joints subequal in length, first fully one-fourth wider than second, second slender, subequal to third and fourth together. Prothorax about as long as wide, feebly arcuate at the sides, more strongly so toward apex; feebly, narrowly impressed near the base, surface of disk coarsely, rather densely, irregularly punctate, interspaces finely densely punctulate. Elytra distinctly wider at base than prothorax, umbones not prominent, feebly arcuate at sides, apex moderately narrowed; first two intervals feebly impressed at base; apices not separated; surface finely punctulate, subalutaceous; strial punctures moderately large, each with a white seta directed posteriorly, arranged with a very strong tendency to regular, widely separated rows, especially in the basal half, where the scales are exceptionally fine and short. Ventral surface with long gray hairs, somewhat sparser on the legs. Anterior tibiae serrate along inner margin.

Length, 8.2–9 mm.; width, 2.3–3 mm.

Rostrum in the female a little longer than in the male, about two and a half times as long as wide.

Male rostrum more robust and shorter, scarcely more than twice as long as wide.

Type locality.—Indiana (H. F. Wickham).

Other localities.—Havana, Ill.; Algonquin, Ill. (Nason); Woodridge, D. C. (L. L. Buchanan); Mobile, Whistler, and Magazine Point, Ala. (H. P. Löding); Baton Rouge, La. (T. H. Jones).

Type.—Female, Cat. No. 28832 U.S.N.M. Type, allotype, and three paratypes. Paratypes also in the collections of the Illinois State Natural History Survey, and of H. P. Löding.

In many respects this species closely resembles the allied *cleonoides*, new species, the differences being largely comparative but sufficient for specific differentiation. The rostrum is longer and more robust, the body is on the average wider, and the vestiture of the dorsum is more profuse.

LIXUS CLEONOIDES, new species

Elongate, subcylindrical, a little less than four times as long as wide, black, only moderately shining, vestiture dense, forming a broad whitish-gray lateral vitta extending from the back of the eyes to the apex of the elytra; sharply limited on prothorax, but vaguely defined on elytra; antennae dull reddish brown; elytra and first and second pairs of legs densely covered with narrow dark brown scales. Head finely punctate, interocular and interantennal foveae connected by a fine thin carina. Rostrum in the male a little shorter than the pronotum, moderately thick, narrowing to apex, nearly evenly and distinctly arcuate; surface finely punctate, with a row of a few punctures each side, punctures nearly concealed by the vestiture; apex still more finely punctate. First funicular joint notably widest and longest, second narrow, not so long as next two combined; surface with very fine scales and sparse pale setae; scrobes extending nearly two-thirds toward apex. Pronotum wider than long, conical, depressed; sides feebly arcuate, basal third subparallel, apical two-thirds gradually narrowing to apex; surface with rather large, moderately dense punctures, more widely spaced along middle; interspaces densely punctulate. Antescutellar region very slightly impressed. Elytra slightly wider at base than pronotum, angles not prominent, humeri not prominent, sides for three-fourths their length parallel, postscutellar region feebly impressed, lateral basal region hardly impressed; strial punctures, except at extreme base, fine and sparse. First and second ventral segments finely ocellate, last three with very long hairs, especially at the sides. Middle and posterior femora incompletely annulate. Anterior tibiae distinctly serrate.

Length, 8.75 mm.; width, 2.75 mm.

Type locality.—Stamford, Tex., June 17, 1907. On *Helenium microcephala* DC. (Hunter No. 1436).

Type.—Cat. No. 29032, U.S.N.M.

This is a well-defined species. First, the brown body color due to the scaly covering is unusual and the broad lateral vitta and the arcuate and thick rostrum are noteworthy, as are also the unimpressed sides of the elytra at the base. The single tuft of hair on the lower

surface of each femur evidently corresponds to the ring or annulus, usually only partially completed, near the apex of the femur noted in many species of the genus.

LIXUS MEPHITIS, new species

Form elongate fusiform, three times as long as wide, polished black, except on lower surface, with a conspicuous white lateral vitta, wider and rather broad on the prothorax, becoming denser and gradually narrower on the elytra until it attains the apex; antennae bright red. Head wide, convex, finely, densely punctate, more coarsely between the eyes; interocular fovea of moderate size, rounded. Rostrum in the female distinctly shorter than the pronotum, robust, scarcely three times as long as wide, wider basally, narrower in apical third, cylindrical, moderately arcuate, completely noncarinate; interantennal fovea indistinct; surface rather finely punctate at base, finely punctulate apically, coarser at sides above antennae. Antennae inserted at a point less than half the length of the rostrum from the base; first funicular joint distinctly narrower than the scape; second joint much narrower but of similar length, slightly longer than third and fourth combined, these latter very short; club covered with gray pubescence. Prothorax slightly wider than long, basal two-fifths parallel at sides, thence evenly narrowed to apex; disk irregularly, rather feebly, variolately punctate; interspaces finely punctulate; surface covered with short gray scale like hairs; antescutellar impression very small. Elytra distinctly wider than the prothorax, a little more than twice as long as wide, subparallel in basal three-fourths; a short postscutellar area embracing first two elytral striae flat, fifth and sixth striae at base forming a shallow depression; base bisinuately elevated. Elytral striae composed of coarse punctures, closely set in quite regular rows, forming rugae as viewed from the sides; vestiture comparatively sparse, becoming mildly mottled, particularly toward the apex; lateral vitta covering the eighth and ninth intervals for a short distance at base, but the eighth only from basal fourth to apex. First ventral segment coarsely and rather sparsely punctate, comparatively sparsely pubescent; second as long as third and fourth together, fifth nearly flat, all widely separated. Legs long, sparsely covered with short gray hairs; femora strongly clavate; anterior tibiae strongly serrate on inner face.

Length, 7.5 mm.; width, 2.5 mm.

Type locality.—Myrtle Beach, Horry County, S. C. April 22, 1919 (E. R. Kalmbach).

Type.—Female, Cat. No. 29035, U.S.N.M.

This beautiful species is quite distinctive in the Group II of Blatchley and Leng 1916–340, in which it falls because of the an-

tennal characters. There are no others in this group in which the vestiture is condensed into such distinct narrow white elytral vittae.

LIXUS ELEPHANTULUS, new species

Elongate cylindrical, about three times as long as wide; head, rostrum, and prothorax black, elytra and femora dark reddish brown, apices of femora, tibiae, tarsi, and antennae red; vestiture not vittate, of dorsum moderately long, mixed with much shorter scale-like hairs on elytra, much longer on lower surface. Head wide, prominent, finely, rather densely punctate on occiput, coarser punctures forming rows longitudinally between the eyes. Rostrum in the female longer than the prothorax, rather strongly and nearly evenly arcuate, finely carinate, carina extending from the elongate interocular fovea to the somewhat indistinct interantennal fovea; surface coarsely punctate at the sides near the eyes, finer toward apex; first and second funicular joints subequal, second narrower, about as long as third and fourth together. Pronotum about one-fourth wider than long, sides nearly evenly arcuate; surface rough, subrugose, without distinct asperities, punctation coarse and sparse, punctures shallow, not variolate, few at apex, spaces between feebly indistinctly punctulate, antescutellar impression distinct, narrow. Elytra twice as long as wide, scarcely wider at extreme base than pronotum, more distinctly wider at humeri, which are not prominent; sides in basal two-thirds parallel, apices slightly open; postscutellar impression shallow, not definitely horse-shoe shaped, humeral impression feeble; strial punctures coarse and of irregular size, many obscured by thick coating of short scale-like hairs intermixed with tufts of longer ones, gray, yellow, and reddish, not mottled. Ventral surface gray pubescent. First ventral segment with a very small oval median impression at extreme base; surface finely and sparsely punctate; second segment more distinctly convex, fifth flattened across apical half. Femora comparatively slender, tibiae rather strongly arcuate, feebly serrulate on inner face.

Length, 6.8 mm.; width, 2.2 mm.; rostrum, 1.5 mm.

Type locality.—Havana, Ill., August 18, 1912.

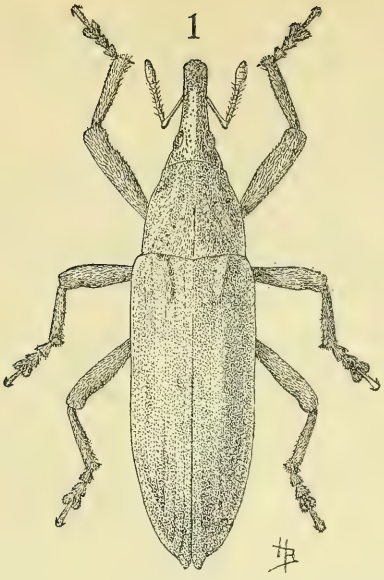
Type.—Female, unique, in collection Illinois State Natural History Survey, Urbana, Ill.

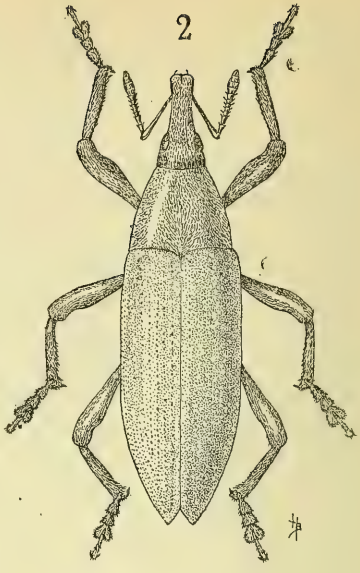
This species is distinctive but not conspicuous. Notable characters are the long curved carinate beak, large and prominent head, red tips of the femora, strongly transverse pronotum, concavity in fifth segment in the female and the abundance of vestiture. There is a trace of reddish pollinose coating in the postscutellar impression.

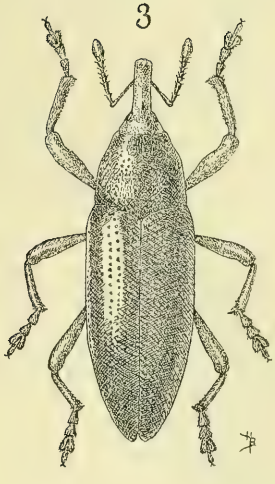
EXPLANATION OF PLATE

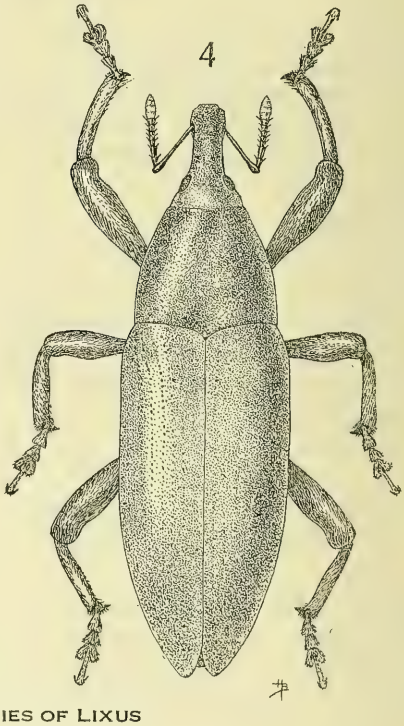
(All figures drawn by Harry Bradford)

FIG. 1. *Lixus pervestitus* Chittenden.
2. *Lixus blakeae* Chittenden. (Ent. Soc. Washington, vol. 30, 1928, p. 90.)
3. *Lixus tricristatus* Chittenden.
4. *Lixus lodingi* Chittenden.









NEW SPECIES OF LIXUS

FOR EXPLANATION OF PLATE SEE PAGE 25

NOTES ON THE RHINOTRAGINE BEETLES OF THE FAMILY CERAMBYCIDAE, WITH DESCRIPTIONS OF NEW SPECIES

By W. S. Fisher

Of the Bureau of Entomology, United States Department of Agriculture

In rearranging the material of this tribe in the United States National Museum collection, it is necessary to describe a number of new forms, and it seems also necessary to record some of the notes which have accumulated with the specimens in the collection.

This tribe contains quite a number of species and genera which are confined to tropical America. They are remarkable both for their generally abbreviated elytra, although this is not an essential character for distinguishing the tribe, and for the mimetic resemblance that many of the species bear to Hymenoptera and other Coleoptera. Although the species are not great favorites with the systematist on account of the difficulty of separating the genera, they are full of interest to the general entomologist, because of their mimicry and the many fine illustrations they offer of the mode in which divergent modifications occur in nature. For example, it is most interesting to observe in forms so closely allied that while some species have rudimentary elytra and wasplike bodies or beelike posterior tibiae, such as the species of *Odontocera*, *Tomopterus*, *Epimelitta*, etc., others have the elytra developed to the opposite extreme, and, aided by their general aspects and colors, become analogous to other Coleoptera, such as *Oxylymma* resembling the Galerucinae, the *Erythroplatys* the Hispinae, and the *Ornistomus* various species of Lycidae.

If we believe in the origin of species by natural variation and selection, the species of Rhinotragini have varied in many directions, and since a protective disguise of one kind or another was necessary to the species, these variations have been gradually extended in many directions to mimic some species which it was advantageous to resemble. In some of the very closely allied species the most abrupt changes are seen, as for instance, between *Odontocera fasciata* Olivier (which resembles a wasp) and *Odontocera compressipes* White

No. 2842.—Proceedings U. S. National Museum, Vol. 77, Art. 19

2604—30——1

(which resembles a bee, with a pollen-collecting brush of hairs on each posterior tibia). The abruptness with which important structural parts change from species to species renders the definition of genera almost impossible in this tribe, as almost every species offers sufficient characters to render generic separation plausible for the extremist.

An almost universal character of this tribe is the large eyes, especially the lower lobes, which in the males are nearly contiguous in front, but even this character disappears in a few species. The head is generally elongate below the eyes, but this character exists in some of the other tribes of Cerambycidae. The pronotun is cylindrical or ovate and unarmed at the sides. The antennae are almost always more or less serrate from the sixth joint, and the intermediate joints are armed with setae on their inner margins. The prosternal process is always present between the anterior coxae, although it is very narrow in a few species, and the episterna of the metasternum are always triangular and very broad in front.

The adults, whose short elytra and strongly developed membranous wings permit them to fly swiftly, frequent flowers in company with the Hymenoptera, which many of them resemble.

ODONTOCERA FASCIATA (Olivier)

Necydalis fasciata OLIVIER, Entomol., vol. 4, gen. 74, 1795, no. 9, p. 10, pl. 1, fig. 9.

Odontocera vitrea SERVILLE, Ann. Soc. Ent. France, vol. 2, 1833, pp. 547–548.

Odontocera chrysozone WHITE, Cat. Col. British Museum, pt. 8, 1855, p. 192, pl. 5, fig. 5.

This species was originally described by Olivier (1795) from South America. Serville (1833) redescribed the same species from Cayenne under the name of *vitrea* and placed it as the first species in his new genus *Odontocera*, and White (1855) redescribed it from the Amazon under the name of *chrysozone*.

This species seems to have a rather wide distribution. Bates[1] writes that it is generally distributed throughout the Amazons, and is not uncommon in the dry season at sweet-smelling flowers. Like all the other species among the beautifully varied and interesting little creatures of this tribe, it flies nimbly from flower to flower, deceiving the eye of the beholder by its strong resemblance to a wasp. A large series has been examined by the writer and scarcely any variations were observed except in size. P. J. Darlington, jr., reared examples of both sexes from the dead wood of *Triplaris* species at Rio Frio, near Santa Marta, Colombia, during May, 1928. James Zetek reared it in numbers from avocado branches collected at Summit, Canal Zone, during 1927, and Ferd. Nevermann collected

[1] Trans. Ent. Soc. London, 1870, p. 324.

adults at Hamburg farm, Costa Rica, August 15, 1923, on fallen "*Quararibea turbinata.*"

ODONTOCERA TRIPLARIS, new species

Male.—Form similar to *fasciata* Olivier. Head and pronotum yellow, the latter with the anterior margin and base in front of scutellum narrowly black, and the disk ornamented with reddish brown as follows: An oblique spot on each side at lateral margin, a longitudinal median vitta extending from anterior margin to base, and arcuately expanded at anterior margin and middle, and an arcuate vitta on each side of middle, more or less interrupted at middle, and not extending to anterior margin or base; antennae reddish brown; elytra pale yellow, vitreous, with the margins narrowly reddish brown, and a spot of the same color on each elytron near base; beneath uniformly pale yellow.

Head with the front short, flat between the eyes, and with a narrow longitudinal groove extending from vertex to middle of front; surface glabrous, coarsely, vaguely punctate, becoming finely granulose on the occiput. Eyes separated from each other on the front by about the width of the labrum. Antennae short, extending slightly beyond base of elytra; joint 1 shining and sparsely punctate, the following joints subopaque and densely pubescent, and some of the joints armed with long erect hairs on inner margin; joint 1 robust, arcuate, and rather strongly clavate; joints 2 to 4 subcylindrical, the third distinctly longer than the fourth, which is slightly enlarged toward apex; joints 5 to 10 serrate; joint 11 oblong, and acute at apex.

Pronotum about as wide as long; sides arcuately rounded and strongly constricted toward base; anterior margin and base strongly elevated; surface with the median dark area slightly elevated at middle, finely, confluently punctate or granulose, and clothed toward the sides with short, inconspicuous yellow pubescence. Scutellum triangular, and clothed with a few inconspicuous hairs.

Elytra extending to apex of third abdominal segment, with the tips obliquely truncate and the exterior angles acute, the sutural margins strongly elevated, slightly narrowed, and moderately dehiscent posteriorly; surface with the reddish brown areas clearly defined, glabrous, and densely, coarsely punctate, the vitreous areas finely, very sparsely punctate, and each puncture with a short, erect black hair.

Abdomen beneath coarsely, vaguely punctate, except the first segment, and rather densely clothed with inconspicuous, recumbent yellow hairs. Sternum sparsely clothed with long, semierect yellow hairs. Anterior and middle legs short, and the femora strongly, abruptly clavate. Posterior legs long, the femora strongly, abruptly clavate, and the tibiae straight and cylindrical.

Female.—Differs from the male in having the eyes separated from each other on the front by about twice the width of the labrum, and the antennae slightly shorter.

Length, 12–16 mm.; width, 2.6–3.6 mm.

Type locality.—Rio Frio, near Santa Marta, Colombia.

Type, allotype, and paratypes.—Cat. No. 42820, U. S. N. M.

Paratypes.—Darlington collection.

Described from 48 examples (one type), all of which were reared during 1928 by P. J. Darlington, jr., from the dead wood of *Triplaris* species. Darlington was unable to get the specific name of this tree, but he writes that it is the only narrow-leaved species of this genus found commonly along the banks of brooks in the foothills. In a large series of specimens of this species examined, very little variation was observed except in size. There is a slight variation in the shape of the pronotum; in some examples it is slightly wider than long, whereas in others it is slightly longer than wide. The reddish brown markings on the pronotum are also somewhat variable; in some examples the arcuate vittae are distinctly separated in the middle, and in others they are connected anteriorly to the oblique lateral spot.

This species is allied to *tridentifera* Gounelle described from Argentine Republic, but differs from that species in having the head entirely yellow in front, the antennae uniformly reddish brown, pronotum ornamented with three longitudinal reddish brown vittae, which are more or less interrupted at the middle, but not connected to each other at the base, scutellum yellow and nearly glabrous, and in having the tips of the elytra obliquely truncate, with the exterior angles acute.

ODONTOCERA BUSCKI, new species

Male.—Form similar to *fasciata* Olivier. Head yellow, with a black spot on occiput between upper lobes of eyes; antennae reddish brown, with the dorsal surface of first and second joints black; pronotum yellow, with the anterior margin and base broadly margined with black, the black margin on base becoming narrower at the sides, and the disk ornamented with black markings as follows: A transverse sinuate fascia at middle extending nearly to coxal cavities, a longitudinal median vitta extending from anterior margin to base, and wider behind the transverse fascia; scutellum black; elytra pale yellow, vitreous, with the lateral and sutural margins narrowly brownish red posteriorly, becoming blackish toward the base, and with an elongate arcuate black fascia behind the base of each extending from the lateral margin at basal fourth to the sutural margin a short distance behind the scutellum; body beneath yellow, with the apical segments of the abdomen dark brown, and orna-

mented with black markings as follows: A longitudinal vitta on each side of the head below the eyes, a transverse fascia on anterior part of prosternum, posterior margin of prosternum, a small round spot on each side of prosternum near base, an elongate spot on anterior coxae, anterior margin of episternum, an arcuate fascia on each side of sternum, margin of posterior coxae, and the margins of posterior intercoxal process.

Head with the front short, transversely depressed behind the epistoma, flat between the eyes, and with a narrow longitudinal groove extending from vertex to middle of front; surface glabrous, nearly smooth in front, but becoming densely ocellate-punctate on the occiput. Eyes separated from each other on the front by about one-half the width of the labrum. Antennae short, extending to base of first abdominal segment; joints 1 and 2 shining, and rather densely, coarsely punctate, the following joints subopaque, densely pubescent, and some of the joints armed with long, erect hairs on inner margin; joint 1 robust, straight, and slightly clavate; joints 2 to 4 subcylindrical, the third twice as long as the fourth, which is slightly more robust and feebly enlarged toward apex; joints 5 to 10 serrate, and the joints becoming gradually shorter toward the tip of the antennae; joint 11 oblong, acute at apex, and strongly emarginate.

Pronotum about as wide as long, with the sides regularly arcuately rounded, and the anterior margin and base strongly elevated; disk strongly convex, without tubercles or carinae; surface densely ocellate-punctate, and sparsely clothed with a few inconspicuous hairs. Scutellum triangular, and densely clothed with yellowish pubescence.

Elytra extending to base of fourth abdominal segment, with the tips transversely truncate and vaguely emarginate, the sutural margins strongly elevated, slightly narrowed, and moderately dehiscent posteriorly; surface with the opaque areas coarsely, confluently punctate, and clothed with a few erect hairs in the basal region, the vitreous areas glabrous, and sparsely, obsoletely punctate.

Abdomen beneath sparsely, coarsely punctate, except the basal segments, and sparsely clothed with long erect and recumbent hairs intermixed. Sternum sparsely clothed with long, erect yellow hairs. Anterior and middle legs short, and the femora strongly, abruptly clavate. Posterior legs long, and sparsely clothed with long, stiff, erect black and yellow hairs intermixed, the femora strongly, abruptly clavate, and the tibiae straight and cylindrical.

Female.—Differs from the male in having the eyes separated from each other on the front by nearly twice the width of the labrum, and the antennae slightly shorter.

Length, 11.5 mm.; width, 2.4 mm.

Type locality.—Trinidad River, Panama (type); Tabernilla, Canal Zone (allotype).

Type and allotype.—Cat. No. 42821, U. S. N. M.

Described from two examples, the male (type) collected at Trinidad River, Panama, May 7, 1911, by August Busck, and the female (allotype) collected at Tabernilla, Canal Zone, July 23, 1907, by the same collector.

This species is allied to *tridentifera* Gounelle, but is easily distinguished from that species by having the three transverse black fasciae on the pronotum connected to one another by a median longitudinal vitta of the same color.

ODONTOCERA ZETEKI, new species

Male.—Form similar to *fasciata* Olivier. Head pale yellow, with a transverse black fascia on the occiput between the eyes; antennae yellowish brown, with the dorsal surface of the basal joint black; pronotum pale yellow, with a broad, transverse black fascia at middle, and along the base and anterior margin; scutellum and elytra pale yellow, the latter vitreous, with the lateral and sutural margins narrowly brownish black, and with a narrow oblique black fascia on each elytron extending from the humerus obliquely backward to the sutural margin behind the scutellum; beneath pale yellow, the legs slightly more brownish, and the body ornamented with black markings as follows: A narrow fascia along anterior margin of prosternum, a transverse fascia at middle and along base of prosternum, but broadly interrupted at middle, base of each abdominal segment, and numerous irregular spots on each side of the mesosternum and metasternum.

Head with the front short, and transversely depressed behind the epistoma; surface nearly smooth in front, becoming coarsely, densely punctate on the occiput, and rather densely clothed with short, recumbent yellow pubescence. Eyes nearly contiguous in front. Antennae short, extending to middle of first abdominal segment, and rather strongly enlarged toward the apex; joint 1 shining, and coarsely, sparsely punctate, the following joints subopaque, rather densely pubescent, and some of the joints armed with long, erect hairs on inner margin; joint 1 robust and slightly arcuate; joints 2 to 4 subcylindrical, the third twice as long as the fourth, which is sligthly more robust and feebly enlarged toward apex; fifth joint slightly longer and more strongly enlarged toward apex than the fourth; joints 6 to 10 compact, slightly serrate, and becoming shorter and broader toward the tip of the antennae; joint 11 oblong, and acute at apex.

Pronotum distinctly longer than wide, with the sides feebly, arcuately rounded, slightly more strongly narrowed posteriorly, and the base and anterior margin slightly elevated; disk moderately convex, without tubercles or carinae; surface coarsely, confluently ocellate-punctate, the yellow fasciae densely clothed with long, recumbent yellow pubescence, and the black fasciae with a few long, erect, inconspicuous hairs. Scutellum densely clothed with recumbent yellow pubescence.

Elytra extending to middle of second abdominal segment, with the tips transversely truncate, and the sutural margins feebly elevated, slightly narrowed, and moderately dehiscent posteriorly; surface with the dark margins coarsely, confluently punctate, the vitreous areas sparsely, obsoletely punctate in basal region, and the surface clothed with a few inconspicuous erect hairs.

Abdomen beneath coarsely, vaguely punctate, except the basal segments, and rather densely clothed toward the sides with recumbent yellow pubescence. Sternum rather densely clothed with long, erect and recumbent yellow hairs intermixed. Legs sparsely clothed with long, erect hairs; anterior and middle legs rather short, and the femora strongly, abruptly clavate; posterior legs long, the femora gradually clavate, and the tibiae straight and cylindrical.

Female.—Differs from the male in having a longitudinal black vitta and a narrow longitudinal groove on front of head between the eyes, which are separated from each other on the front by nearly twice the width of the labrum.

Length, 11–14.5 mm.; width, 2–2.6 mm.

Type locality.—Barro Colorado Island, Canal Zone.

Type, allotype, and paratypes.—Cat. No. 42822, U. S. N. M.

Described from eleven examples, four males and seven females (one type), all of which were reared August 8, 1927, by James Zetek, from a small branch of an unknown tree, which had been girdled by a cerambycid, and collected at the type locality. In the series examined scarcely any variation was observed except in size.

This species resembles *fasciata* Olivier very closely, but can be easily distinguished from that species because it has three black and two pale yellow transverse fasciae on the pronotum, whereas in *fasciata* there are four black and two pale yellow fasciae and a median brownish yellow fascia on the pronotum. *Odontocera fasciata* is also more robust, and the elytra are longer, extending to the base of the fourth abdominal segment, the tips being acute and strongly emarginate.

ODONTOCERA NEVERMANNI, new species

Male.—Form similar to *sanguinolenta* Bates. Head, antennae, pronotum, and scutellum black; elytra pale yellow, vitreous, with the lateral and sutural margins and the base broadly black; beneath black, with the bases of the posterior tibiae and femora broadly pale yellow.

Head with the front rather long, and flat between the eyes; surface glabrous, coarsely, irregularly punctate, and longitudinally rugose on the front, becoming coarsely, confluently punctate on the occiput. Eyes separated from each other on the front by about the width of the labrum. Antennae short, robust, extending to base of first abdominal segment, and with the intermediate joints widest; joints 1 to 3 shining, coarsely punctate, and the third densely pubescent, the following joints subopaque, densely pubescent, and some of the joints armed with long, erect hairs on the inner margin; joint 1 robust, slightly arcuate, and rather strongly clavate; joints 2 to 4 subcylindrical, the third twice as long as the fourth, which is slightly more robust; joints 5 to 10 strongly serrate, the outer anterior angle of the joints acute, and the joints becoming narrower and shorter toward tip of antennae; joint 11 oblong and acute at apex.

Pronotum distinctly longer than wide, the sides feebly arcuately rounded in front, and broadly arcuately constricted behind the middle, the anterior margin strongly elevated; disk strongly convex, without tubercles or carinae; surface coarsely, transversely rugose, coarsely, irregularly punctate between the rugae, and clothed with a few inconspicuous erect hairs. Scutellum densely clothed at apex with long, recumbent cinereous pubescence, which conceals the surface.

Elytra extending to apex of third abdominal segment, the tips broadly subtruncate or obtusely rounded, the sutural margins feebly elevated, slightly narrowed, and slightly dehiscent posteriorly; surface glabrous, with the black areas coarsely, confluently punctate, becoming somewhat scabrous in basal region, and the vitreous area coarsely, obsoletely punctate.

Abdomen beneath shining, very sparsely, finely punctate, and clothed with a few inconspicuous erect hairs. Sternum sparsely clothed with long, erect hairs on posterior half, and the anterior half densely clothed with short, recumbent cinereous pubescence. Anterior and middle legs short, the femora strongly abruptly clavate. Posterior legs moderately long, clothed with long, erect black hairs, the femora strongly clavate, and the tibiae straight and cylindrical.

Length, 15 mm.; width, 3.2 mm.

Type locality.—Hamburg farm, which is situated on the Raventazon River about midway between Siquires and the coast in Costa Rica.

Type.—Cat. No. 42824, U. S. N. M.

Described from a single male collected flying around cut down trees at the type locality, May 21, 1925, by Ferd. Nevermann.

This species is allied to *sanguinolenta* Bates, but it differs from that species in being larger, the antennae robust but with the intermediate joints widest, and the pronotum and underside of the body uniformly black, except the base of the posterior tibiae and femora, which are pale yellow.

ODONTOCERA DARLINGTONI, new species

Female.—Form similar to that of *fasciata* Olivier. Head and pronotum yellow, the latter ornamented with black markings as follows: A large, transverse triangular spot, including the anterior margin; a large, straight, transverse fascia in front of scutellum, but not extending to the lateral margins; a transverse sinuate fascia at middle extending nearly to the coxal cavities, which is more or less interrupted externally; and an elongate spot at middle connected posteriorly to the median fascia, but not extending to the transverse spot in front of scutellum; antennae reddish brown; scutellum yellow, with the base blackish; elytra pale yellow, vitreous, with the lateral and sutural margins narrowly reddish brown, and each with an arcuate blackish fascia extending from the humeral region backward to the sutural margin a short distance behind the scutellum; body beneath uniformly yellow (except margin of each posterior coxa which is black), and with a more or less distinct brownish tinge.

Head with the front short, transversely depresssed behind the epistoma, flat between the eyes, and with a longitudinal groove extending from vertex to frontal depression; surface glabrous, coarsely, irregularly and vaguely punctate in front, becoming finely punctate or granulose on the occiput. Eyes separated from each other on the front by about one and one-half times the width of the labrum. Antennae short, extending to base of first abdominal segment; joints 1 and 2 shining, and rather densely, coarsely punctate, the following joints subopaque, densely pubescent, and some of the joints armed with long, erect hairs on the inner margin; joint 1 robust, slightly arcuate, and gradually clavate; joints 2 to 4 subcylindrical, the third twice as long as the fourth, which is slightly more robust and feebly enlarged toward apex; joints 5 to 10 serrate and about subequal in length; joint 11 oblong, acute at apex, and feebly emarginate.

Pronotum vaguely wider than long; sides feebly arcuately rounded, and slightly constricted at base; anterior margin strongly elevated; disk strongly convex, slightly depressed along base, but without

tubercles or carinae; surface densely ocellate-punctate and sparsely clothed with long, inconspicuous hairs toward the sides. Scutellum triangular, and rather densely clothed with long, recumbent yellow pubescence.

Elytra extending to middle of third abdominal segment, with the tips transversely truncate and vaguely emarginate, the sutural margins slightly elevated, slightly narrowed, and moderately dehiscent posteriorly; surface with the opaque areas coarsely, confluently punctate, and clothed with a few scattered hairs in the basal regions, the vitreous areas glabrous, and sparsely, obsoletely punctate.

Abdomen beneath sparsely, coarsely punctate, except the basal segments, and sparsely clothed with long, recumbent yellow pubescence. Sternum sparsely clothed with long, semierect yellow hairs. Anterior and middle legs short, and the femora strongly, abruptly clavate. Posterior legs long, and sparsely clothed with long, stiff, erect black and yellow hairs intermixed, the femora strongly, abruptly clavate, and the tibiae nearly straight and cylindrical.

Length, 11–14 mm.; width, 2.6–3.2 mm.

Type locality.—Rio Frio, near Santa Marta, Colombia.

Type and paratypes.—Cat. No. 42823, U. S. N. M.

Paratypes.—Darlington collection.

Described from five females (one type), all of which were reared during May, 1928, from the dead wood of *Triplaris* species collected at the type locality by P. J. Darlington, jr. Scarcely any variation was observed in the specimens examined, except that in two of these examples there are two small black spots between the eyes on the occiput.

This species is very closely allied to *buscki* Fisher, but it differs from that species in being more robust, with the eyes more narrowly separated from each other on front of head, antennae entirely reddish brown, and the anterior and median transverse fasciae on the pronotum not connected to each other by a longitudinal median black vitta. With a larger series for study, this form may prove to be simply a color variety of that species, but since this form is connected up with its host plant, it seems advisable to separate it from that species, at least for the present.

ACYPHODERES CRIBRICOLLIS Bates

Acyphoderes cribricollis BATES, Trans. Ent. Soc. London, 1892, p. 160, pl. 6, fig. 6.

This species was described from three males from Ventanas in Durango, Mexico. A small series including both sexes were collected by Ferd. Nevermann at Hamburg farm, Costa Rica, August 15, 1923, on fallen "*Quararibea turbinata.*" This is a very elongate

slender species, with the elytra long and only slightly dehiscent posteriorly, in which respect it resembles some of the species of *Odontocera*, but on account of the longitudinal elevations on the pronotum it is placed in the genus *Acyphoderes*. In the series examined scarcely any variation was observed in the color and markings, but the females differ from the males in having the eyes separated from each other on the front of the head by about one and one-half times the width of the labrum, and the antennae are slightly shorter.

ACYPHODERES BAERI Gounelle

Acyphoderes baeri GOUNELLE, Bull. Mus. Nat. Hist. Paris, vol. 19, 1913, pp. 222–224, fig.

This species seems to be rather common and was described from a large series of specimens from Argentine Republic, Paraguay, and Brazil. Material has been examined by the writer from Bolivia (locality not recorded), and the following localities in Argentine Republic: Tucuman, collected during December, 1917, and January, 1918, by E.W. Rust, and from El Quemado, Jujuy, between March and May, 1926, by G. L. Harrington.

The species shows great variation in color and markings. The typical form is uniformly black above, except for the vitreous areas on the elytra, and this color varies to specimens in which the elytra are reddish brown, and the pronotum black, with yellow vittae. Gounelle [2] has described two of these aberrations in which the elytra are reddish brown and the pronotum ornamented with yellow vittae under the names of *flavonotata* and *biannulata*. In the material collected by Harrington at El Quemado, the typical form, aberration *biannulata* Gounelle, and a form with the elytra reddish brown and the pronotum entirely black were found. E. W. Rust in a letter writes of this species as follows:

> There are also a fly and a moth which resemble these beetles so closely that you can scarcely tell the difference when collecting, and all resemble so closely the wasp *Megacanthopus ater* Olivier that I never know which one is going to sting me when I collect them. All four frequent the flowers of *Baccharis* sp. on hot days, and the appearance, habits of flight, and the attitude of the wings in repose or while walking over the flowers is almost identical in all four cases. The beetle with the wings outspread is the nearly natural position it assumes when feeding among the flowers.

This species is frequently erroneously identified as *Sphecomorpha murina* Klug, which it resembles very closely. It can, however, be separated from that species in having the pronotum biimpressed and the elytra gradually narrowed to the apices, each of which terminates in an acute spine, whereas in *murina* the pronotum is strongly

[2] Bull. Mus. Nat. Hist. Paris, vol. 19, 1913, pp. 223–224, figs. 1–4.

convex, and the elytra are abruptly dehiscent at the middle, with the posterior half of each narrow, parallel, and the tip not terminating in a spine.

ACYPHODERES AURULENTA (Kirby)

Necydalis aurulenta KIRBY, Trans. Linn. Soc. London, vol. 12, 1818, p. 443.
Acyphoderes sericinus WHITE, Cat. Col. British Museum, pt. 8, 1855, p. 195.

This species was described by Kirby (1818) from Brazil, and White (1855) redescribed the same species under the name of *sericinus* from the same country. In the United States National Museum are two examples of this species which were identified as *abdominalis* Olivier. One of these examples is labeled Mayaguez, Porto Rico, and the other one Cayey, Porto Rico, May 23, 1923, collected by G. N. Wolcott. These two specimens show a slight variation from the typical specimens from Brazil by not having the femora and tibiae black in the middle, and by the elytra being without a furcate black vitta on each side, but these specimens seem to be the extreme light form of this species, and not sufficiently distinct to warrant a new name. In a series examined from Brazil, all of the examples have the black bands on the legs, but in a few of these examples the furcate black vittae on the elytra are absent.

This species is closely allied to *abdominalis* Olivier, but that species differs from *aurulenta* in having the pronotum more sparsely pubescent, and the elytra shining black, each with a short humeral vitta, a small spot on each side of the scutellum, and the vitreous areas pale yellow. The specimens listed as *abdominalis* from Porto Rico by Gahan,[3] and Leng and Mutchler[4] are probably *aurulenta* (Kirby).

ACYPHODERES RUFOFEMORATA, new species

Female.—Form rather slender. Head, antennae, pronotum, and scutellum black; elytra pale yellow, vitreous, with well defined black margins, which are considerably narrower along the sutural margins except for a short distance behind the scutellum. Body beneath black; anterior and middle legs black, except the femora which are pale yellow at the base; posterior legs black, the femora pale yellow on basal half, with a black ring at beginning of club, which is bright red.

Head with the front long, feebly concave between the eyes, and with a vague, narrow, longitudinal carina extending from occiput to middle of front; surface coarsely, irregularly punctate, and sparsely, irregularly clothed with rather long, recumbent yellow hairs. Eyes separated from each other on the front by about one-half the width

[3] Trans. Ent. Soc. London, 1895, p. 111.
[4] Bull. Amer. Mus. Nat. Hist., New York, vol. 37, 1917, p. 446.

of the labrum. Antennae extending to base of first abdominal segment; joints 1 to 3 shining and sparsely punctate, the following joints opaque and densely pubescent; joint 1 slightly clavate; joints 2 and 3 slender and cylindrical, the second small, and the third about as long as the fourth and fifth united; joint 4 feebly enlarged toward apex; joints 5 to 10 compact and slightly serrate; joint 11 oblong, and acute at apex.

Pronotum slightly longer than wide; sides arcuately rounded, and feebly constricted at base; surface depressed, somewhat uneven, but without distinct longitudinal ridges, densely, coarsely, and confluently punctate, and rather densely, irregularly clothed with moderately long, recumbent black and yellow pubescence, with a few erect hairs of the same color intermixed. Scutellum triangular, and densely clothed with yellow pubescence.

Elytra extending to middle of third abdominal segment, rather strongly subulate, strongly dehiscent posteriorly, with the tips narrowly rounded; surface glabrous, with the black margins densely, coarsely punctate, becoming tuberculous at the base, and the vitreous areas sparsely, obsoletely punctate.

Abdomen beneath shining, rather coarsely, irregularly punctate, and irregularly clothed with recumbent and erect hairs. Sternum rather densely, irregularly clothed with long, recumbent pale yellow pubescence. Anterior and middle legs short, femora strongly clavate, and the anterior tibiae densely clothed with short brownish pubescence on inner sides. Posterior legs long, femora rather strongly clavate near apex, and the tibiae clothed with erect black hairs, which are denser and longer on the apical half.

Length, 17–18 mm.; width, 3.25–3.5 mm.

Type locality.—Bahia, Brazil.

Type and paratype.—Cat. No. 42825, U. S. N. M.

Described from two females (one type) collected at the type locality.

This species is closely allied to *femorata* Klug and *carinicollis* Bates. It differs from the former in having the abdomen and tarsi black, and the club of the posterior femora bright red. It resembles *carinicollis* Bates very closely, but *rufofemorata* is larger and more robust than that species, the anterior and middle legs are black except at the base, and the pronotum is not distinctly trisulcate.

BROMIADES BRACHYPTERA (Chevrolat)

Odontocera brachyptera CHEVROLAT, Rev. Zool., 1838, p. 285.

This species was described from Cuba by Chevrolat, who recorded it as common in all parts of the island during June on the flowers of Jucaro. He also recorded it as living in the wood of Java

(*Andira inermis*). In the United States National Museum collection is a specimen from Habana, Cuba, collected by C. F. Baker, another example from Central Constancia, Cuba, collected by J. F. Merrill, and two examples collected at Cayuga, Guatemala, during September and October by William Schaus. Another example has been examined from the Ferd. Nevermann collection which was collected at San José, Costa Rica, June 20, 1924, by E. Gonzora. Bates [5] records it from Cuba and Santa Marta, New Granada, but states that the specimen from the latter locality differs from the Cuban form in having the hind legs wholly tawny red, with the exception of the two apical joints of the tarsi, which are black. This specimen is without any doubt the same as my new species, *Bromiades meridionalis* from Panama, so *brachyptera* should not be listed in the catalogues from New Granada.

BROMIADES MERIDIONALIS, new species

Female.—Form similar to *brachyptera* Chevrolat. Head, antennae, pronotum, scutellum, and elytra black, the latter each with a broad, median longitudinal pale yellow vitreous area extending from base to near apex. Body beneath black; anterior and middle legs black, with a more or less reddish yellow spot near the base of the femora; posterior legs yellow, except the femora, which have the swollen parts slightly more brownish and the tips narrowly margined with black, the three apical joints of the tarsi and the tarsal claws black.

Head with the front moderately long, flat between the eyes, and with a smooth longitudinal carina extending from occiput to middle of front, the carina broadly expanded on the occiput; surface coarsely, irregularly punctate, and irregularly clothed with short, recumbent golden yellow hairs. Eyes separated from each other on the front by nearly the width of the labrum. Antennae extending nearly to apex of elytra; joints 1 to 4 shining and sparsely punctate; joints 5 to 11 opaque and densely pubescent, and all of the joints armed with a few long hairs at apex on inner margin; joint 1 strongly clavate; joints 2 to 4 subcylindrical; joint 5 robust and feebly serrate; joints 6 to 10 broadly triangular; joint 11 oblong, and feebly emarginate at apex.

Pronotum about as wide as long; sides arcuately rounded, and strongly constricted near base; surface somewhat depressed, with three broad, smooth, longitudinal elevations, the median one straight and strongly interrupted near base, the lateral ones arcuate, not extending to base or apex, and the surface coarsely rugose posteriorly, the depressions coarsely, irregularly punctate, and densely

[5] Ann. Mag. Nat. Hist., ser. 4, vol. 11, 1873, p. 120.

clothed with long, recumbent golden yellow pubescence. Scutellum triangular, densely clothed with yellow pubescence at apex.

Elytra extending to just beyond base of first abdominal segment, cuneiform, slightly arcuately dehiscent posteriorly, with the tips rather broadly rounded; surface with the black margins clearly defined, glabrous, and coarsely, densely punctate except in the humeral regions, the vitreous areas coarsely, obsoletely punctate, and clothed with a few erect, inconspicuous yellow hairs.

Abdomen beneath slightly flattened, finely, very sparsely punctate, the apical segments densely clothed with short, recumbent cinereous pubescence. Sternum rather densely clothed with short, recumbent cinereous pubescence, with a few long, semierect golden yellow hairs toward the sides. Anterior and middle femora short and strongly clavate; posterior femora long and slightly clavate toward the apices. Anterior and middle tibiae short, densely clothed with golden yellow pubescence on the inner sides; posterior tibiae long, slightly arcuate, clothed with long reddish yellow hairs, which are denser and longer on the apical halves. Tarsi clothed with black hairs except the two basal joints of the posterior legs, which are densely clothed with long reddish yellow hairs, similar to those of the tibiae.

Length, 19 mm.; width, 4 mm.

Type locality.—Cabima, Panama.

Type.—Cat. No. 42826, U.S.N.M.

Described from a single female collected at the type locality, May 26, 1911, by August Busck.

This species is closely allied to *brachyptera* Chevrolat, but differs from that species in having the antennae entirely black, the elytra more arcuately dehiscent toward the tips, and the posterior legs yellow, with the exception of the tips of the femora and the three apical joints of the tarsi, which are black. It also resembles *Acyphoderes abdominalis* Olivier very closely, but can be readily separated from that species by its short cuneiform elytra, which barely pass the base of the first abdominal segment.

PHYGOPODA MANNI, new species

Male.—Head, pronotum, and scutellum black; antennae reddish brown, becoming slightly paler on the basal segments; elytra pale yellow, somewhat vitreous, with the lateral and sutural margins brownish black, the brownish-black areas very broad along the lateral margins, and with an oblique spot of the same color on each elytron behind the scutellum; body beneath black except the last abdominal segment, which is reddish; anterior and middle legs reddish brown, the femora slightly darker; posterior legs black, with the tarsi and bases of femora and tibiae pale yellow.

Head with the front rather short, flat, and with a narrow longitudinal groove between the eyes; surface rather coarsely, irregularly punctate, and rather densely clothed with long, recumbent cinereous pubescence. Eyes narrowly separated on the front. Antennae extending nearly to apex of elytra; joint 1 shining and sparsely punctate, the following joints opaque, densely pubescent, and with a few long, stiff hairs at apex on inner margin; joint 1 slightly clavate; joints 2 to 4 slender and cylindrical, the third only slightly longer than fourth, which is subequal in length to the fifth; joints 5 to 10 triangular, the joints becoming shorter and broader toward tip of antennae; joint 11 oblong, and feebly emarginate at apex.

Pronotum about as wide as long; sides slightly arcuately rounded, and rather strongly constricted at base; surface moderately convex, without tubercles or longitudinal ridges, rather coarsely reticulate-punctate, each puncture with a small round elevation in the middle, and the surface rather densely, irregularly clothed with long, recumbent cinereous pubescence, which is denser along the anterior part of the lateral margins. Scutellum triangular, densely clothed with cinereous pubescence at apex.

Elytra extending to just beyond base of first abdominal segment, abruptly subulate behind the middle, strongly dehiscent posteriorly, the tips narrowly rounded; surface glabrous, with the brownish-black areas coarsely, confluently punctate, and the vitreous areas with a few coarse, inconspicuous punctures.

Abdomen beneath, except last segment, densely clothed with long, recumbent cinereous pubescence, which nearly conceals the surface. Sternum finely, densely punctate, and clothed with pubescence similar to that on the abdomen. Anterior and middle legs short, the femora strongly clavate. Posterior legs very long, the femora feebly, gradually clavate, coarsely scabrous, and sparsely clothed with short, stiff, semierect white hairs; tibiae armed on apical halves with a rather dense tuft of long, erect white and black hairs intermixed, the white hairs predominating apically.

Female.—Differs from the male in having the eyes separated from each other on the front by about the width of the labrum, the antennae shorter, extending only to middle of elytra, and the posterior femora yellowish brown, becoming dark brown on the upper margin and at middle of outer surfaces.

Length, 8.5–9 mm.; width, 2.4 mm.

Type locality.—Rurrenabaque and Canamina, Bolivia.

Type and allotype.—Cat. No. 42827, U. S. N. M.

Described from two examples, the type (male) collected at Rurrenabaque (Beni River), Bolivia, December, 1921, and the female collected at Canamina, Bolivia, July, 1921. Both specimens were

collected by William M. Mann, with the Mulford Biological Exploration in Bolivia during 1921–1922.

This species is allied to *albitarsis* Klug and *fugax* Thomson, but differs from *albitarsis* in not having the pronotum longitudinally carinate, and from *fugax* by having the elytra abruptly subulate and strongly dehiscent posteriorly.

TOMOPTERUS VESPOIDES White

Tomopterus vespoides WHITE, Cat. Col. British Museum, pt. 8, 1855, pp. 176–177, pl. 5, fig. 8.

This interesting little species was described by White from Guatemala, and has been collected in numbers by Ferd. Nevermann at Hamburg farm, Costa Rica, during August, 1925, flying like wasps around freshly cut timber, apparently "Sapotaceae," and he has observed a female depositing eggs in a hole in the dry bark. Nevermann writes that the females seem to be very rare, as out of 35 examples collected, only two were females.

The sexes of this species are quite different; the males have the eyes nearly contiguous in front, and are dull black above, with the anterior and posterior margins of the pronotum, two spots on the metanotum, last dorsal segment of abdomen, and the posterior margins of the ventral surface of the abdominal segments clothed with golden yellow pubescence. The elytra have the anterior part of the lateral margins and a narrow, oblique vitta on each elytron reddish yellow, the vitta extending from the humerus to middle of elytron at apex. The females have the abdomen more robust, the eyes distinctly separated from each other on the front, the surface sparsely clothed with yellowish pubescence, and in addition to the yellow pubescence mentioned on the males, have the median part of the pronotum sparsely, and the scutellum densely clothed with golden yellow pubescence. The reddish yellow margins and vittae on the elytra are distinctly broader, and in some examples these unite and the entire lateral half of the elytron is reddish yellow, which is the form figured by White.

TOMOPTERUS VITTIPENNIS, new species

Male.—Form similar to *quadratipennis* Bates. Above uniformly black, each elytron with the lateral margin and a narrow oblique vitta brownish yellow, the color becoming paler posteriorly, and the vitta extending from the humeral region to apex at middle of elytron; beneath brownish black, with the base of posterior femora and the inner surface of posterior femora and posterior tibiae paler.

Head with the front moderately long, and with a narrow longitudinal carina on the occiput; surface finely, densely punctate, and

densely clothed between and below the eyes with long, recumbent silvery-white pubescence. Eyes nearly contiguous in front. Antennae short, extending to base of pronotum, and strongly expanded toward apex; joint 1 long and strongly clavate; joints 2 to 4 cylindrical, and the third slightly longer than fourth; joint 5 subequal in length to the third, and strongly enlarged toward apex; joints 6 to 10 compact, short, about subequal in length, and only feebly serrate; joint 11 slightly oblong, emarginate, and acute at apex.

Pronotum slightly wider than long, and distinctly narrower at base than at apex; sides arcuately rounded in front of middle, and obliquely narrowed posteriorly to the base; disk strongly convex, with a narrow transverse depression along anterior margin and base; surface coarsely, confluently ocellate-punctate, densely clothed with very short, inconspicuous silvery-white pubescence, which is visible in certain lights only, with a few erect black hairs intermixed, and ornamented with a narrow fascia of long, recumbent yellow hairs along the anterior margin. Scutellum very large, elongate, triangular, and the surface coarsely, confluently punctate.

Elytra very short, not extending to base of abdomen, quadrangular, not dehiscent posteriorly, the tips broadly rounded exteriorly, more or less obliquely toward the sutural margins; surface very coarsely, confluently punctate, and sparsely clothed with fine, inconspicuous, erect hairs in the basal region.

Abdomen beneath rather densely, coarsely punctate, the posterior margin of segments broadly clothed with long, recumbent yellow pubescence. Sternum coarsely, densely punctate, finely granulose, and rather densely clothed with moderately long, recumbent silvery-white pubescence, with a few semierect hairs of the same color intermixed. Prosternum clothed with a few very long, erect black hairs. Anterior legs short; anterior femora robust, gradually clavate; middle femora feebly arcuate, and strongly abruptly clavate. Posterior legs long; femora strongly arcuate, strongly clavate on apical two-thirds; tibiae cylindrical, slightly sinuate.

Length, 8.8 mm.; width, 2.6 mm.

Type locality.—Buenavista, Bolivia.

Type.—Cat. No. 42828, U. S. N. M.

Described from a single male collected at Buenavista, Bolivia, between February and April, 1925, and labeled "Provincia d'Sara, 1,700 ft."

This species is allied to *quadratipennis* Bates, but *quardratipennis* differs from *vittipennis* in having the antennae reddish brown, the base and anterior margin of pronotum narrowly margined with yellow pubescence, a narrow transverse pubescent fascia on each side at lateral margin, the oblique reddish vitta on each elytron extend-

ing from the humeral angle to the apex at sutural margin, the abdominal segments not distinctly margined with yellow pubescence, and the legs reddish brown.

TOMOPTERUS SIMILIS, new species

Male.—Form similar to *quadratipennis* Bates. Above uniformly black, antennae brownish black, with the base of the first joint reddish, and each elytron with the lateral margin very narrowly reddish brown and a short, oblique, smooth ivory white vitta, which does not extend to base or apex of elytron; beneath brownish black, the legs reddish brown, with the base of the posterior femora ivory white.

Head with the front moderately long, broadly, deeply concave between the antennae, and with a short, longitudinal carina on the occiput; surface finely, densely punctate, densely clothed below the eyes with long, recumbent silvery white pubescence, and with a row of similar hairs between the eyes, which are nearly contiguous in front. Antennae short, extending to base of pronotum and strongly expanded toward apex; joint 1 long, arcuate, and strongly clavate; joints 2 to 4 cylindrical, the third distinctly longer than the fourth; joint 5 subequal in length to the third, and strongly enlarged toward the apex; joints 6 to 10 compact, short, subequal in length, and strongly serrate; joint 11 slightly oblong, broadly truncate and emarginate at apex.

Pronotum distinctly wider than long, nearly equal in width at base and apex; sides broadly, arcuately rounded, more strongly toward the base; disk moderately convex, vaguely flattened on top, and with a deep narrow, transverse depression along anterior margin and base; surface coarsely, confluently ocellate-punctate, densely clothed with very short, inconspicuous silvery white pubescence, which is only visible in certain lights, with numerous long, erect black hairs intermixed, and ornamented in the basal depression with long, recumbent golden yellow pubescence. Scutellum very large, elongate, triangular, the surface coarsely, densely, and irregularly punctate.

Elytra very short, not extending to base of abdomen, quadrangular, not dehiscent posteriorly, the tips broadly rounded externally, more or less obliquely toward the sutural margins; surface densely, confluently punctate, the punctures very coarse in basal region, but becoming finer toward the apex, and sparsely clothed with fine, inconspicuous, erect hairs in basal region.

Abdomen beneath finely, densely punctate, the posterior margin of segments densely clothed with long, recumbent pubescence, which is silvery white on basal segments and golden yellow on apical segments. Sternum closely clothed with long, erect and recumbent

silvery white pubescence intermixed. Prosternum sparsely clothed with long, erect black hairs. Anterior legs short; anterior femora robust and gradually clavate. Middle femora strongly arcuate, and strongly, abruptly clavate. Posterior legs long; femora strongly arcuate, and strongly clavate on apical two-thirds; tibiae cylindrical and slightly sinuate.

Length, 8.4 mm.; width, 2.8 mm.

Type locality.—Rio Negro, Bolivia.

Type.—Cat. No. 42829, U.S.N.M.

Described from a single male collected at the type locality during January, 1922, by William M. Mann with the Mulford Biological Exploration in Bolivia during 1921–1922.

This species is allied to *quadratipennis* Bates, but differs from that species in having the antennae brownish black, the transverse basal depression on pronotum densely clothed with golden yellow pubescence, the oblique ivory white vitta on each elytron not extending to the base or apex, and the underside of the abdominal segments broadly clothed along the posterior margins with silvery white or golden yellow pubescence.

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THE TAXONOMY AND HOST RELATIONSHIPS OF THE BITING LICE OF THE GENERA DENNYUS AND EUREUM, INCLUDING THE DESCRIPTIONS OF A NEW GENUS, SUBGENUS, AND FOUR NEW SPECIES

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The Mallophagan genera *Dennyus* and *Eureum* are of particular interest to those who use the host-parasite method of attack in their studies of the phylogeny of either the hosts or the parasites. Species of the two genera infest swifts and swallows, hosts of similar habits but presumably of no phylogenetic unity. Yet in the past species from both types of bird hosts have been placed in both genera.

Harrison (1916) in his catalogue contributed much toward clarifying the synonymy of the species of *Dennyus*. He listed as valid six species of the genus. He also listed four other species, three from *Micropus apus* and one from *Aeronautes melanoleucus* as being synonyms. Of Harrison's six valid species all but one of them come from swifts. This one, *D. latifrons* Carriker and Shull, was taken from a bank swallow.

The genus *Dennyus* has for its type the *Nitzschia burmeisteri* of Denny. The generic name *Nitzschia* Denny (1842), being preoccupied by *Nitzschia* Baer (1827), is superseded by *Dennyus*, a name proposed by Neumann in 1906. The species *burmeisteri* Denny was taken from the same host, *Micropus* (*Cypselus*) *apus*, as *truncatus* Olfers and is, according to Harrison, a synonym of the latter species.

But this type host of the type species of *Dennyus* is also the type host of the type species of *Eureum* Nitzsch! But the type species of *Eureum*, *E. cimicoides* Nitzsch (fig. 5), is a very distinctive one and could not be confused with *truncatus* Olfers from the same host. *E. cimicoides* is a very large and very broad louse and to the unaided eye does suggest a bedbug, as its name indicates. *D. truncatus*, on the other hand, is a slender species.

Included also in *Eureum* Nitzsch besides the type species is another, *E. malleus* Nitzsch, which comes from a swallow, not a swift. The writer has not seen this second species, but has studied a similar one taken from an American swallow, the purple martin.

No. 2843.—Proceedings of the U. S. National Museum, Vol. 77, Art. 20
2606—30——1

This American louse, while very large, flat, and broad, is decidedly different from *E. cimicoides*. It is without eyes; there are no lateral, pronotal spine-bearing lobes, and, most significant of all, the posterior femora and all of the abdominal sternites are without patches of setae. *E. cimicoides*, on the other hand, has all these characters; in fact, it has most of the generic characters that are usually attributed to *Dennyus*, notwithstanding its great width and large size.

Eureum is in fact almost a synonym of *Dennyus;* however, there exist certain characters which separate it from the other swift-infesting species. It undoubtedly should be placed next to them. Likewise the louse from our purple martin should become the type of a new genus. Probably this genus should contain the swallow-infesting species, *malleus* of Nitzsch, but not the swallow-infesting *latifrons* of Carriker and Shull, which certainly is a true *Dennyus*.

The writer has on hand a rather peculiar new species of *Dennyus* which has been well drawn by Dr. E. A. Chapin (fig. 4). This species was taken from a swift, *Cypseloides niger borealis*, on the Pacific coast, and has many of its setae transformed into dark, short, peglike spines. It should be put in a subgenus by itself. Thus we should have the genera *Dennyus* and *Eureum*, including all of the swift-infesting species, while a new genus is erected for two of the swallow-infesting species. The following key will show more clearly the relationships of these four groups.

KEY TO THE GENERA AND SUBGENERA OF THE COMPLEX DENNYUS-EUREUM

1. Eyes present; pronotum produced laterally into spiniferous lobes; posterior femora and certain abdominal sternites with patches of closely set setae ..... 2.

   Eyes wanting; pronotum without spiniferous lateral lobes; posterior femora and all of the abdominal sternites without patches of setae.

   Hirundoecus, new genus.

2. Anterior femora inflated, being about as broad as or even broader than long; setae of transverse abdominal rows not close set; head and body moderate to slender ..... 3.

   Anterior femora but slightly inflated, considerably longer than broad; setae of transverse abdominal rows close set, each being but little more than its width from its adjacent setae; head and body very broad ..... **Eureum Nitzsch.**

3. Setae of head and body normal, none of them being peglike; eyes double, the two on a side being partly fused with each other.

   Dennyus (Dennyus) Neumann.

   Some of the setae on head and body short and peglike and each abdominal tergite bearing a posterior marginal row of normal setae alternating with peglike spines ..... **Dennyus (Ctenodennyus), new subgenus.**

Genus DENNYUS Neumann

Ferris (1916), in one of his first papers on the Menoponidae, has pointed out the relationship of *Dennyus* to the genera *Myrsidea*, *Actornithophilus*, and *Heleonomus* in the passession of patches of setae on the ventral surfaces of the posterior femora and on certain

abdominal sternites. He also notes that in the development of the mesothorax and the shape of the head these four genera have much in common. His diagnosis of the genus is good, but a restudy of the species, and also those of *Eureum* necessitates new definitions for the old characters and the addition of new characters. The genus *Dennyus* is redescribed as follows:

Antennal fossae partly roofed over above by an expansion of the head; eyes double, the two conreas of one side being partly fused; esophageal sclerite small or wanting; temporal lobes pronounced, quadrangular.

Prothorax rather narrow, but pronotum expanded laterally into a pair of spine-bearing lobes; prosternal plate well developed, with heavy chitinous borders. Mesothorax small but usually distinct and spearated from metathorax by a dorsal suture.

Abdomen long; pleurites each typically with a marginal row of spines and a small tuft of long hairlike setae; tergites bare except for a posterior marginal row of setae. Some of the abdominal sternites with patches of setae of about the same size as those clothing the body.

Genital armature of male symmetrical, with long, narrow basal plate; parameres not united, free, clasperlike; endomeres short, never clasperlike; penis not developed.

Legs of the first pair short, others long; first femora very short, frequently as broad as long; last femora very long, each with a patch of setae below. All tibiae with an indistinct pseudarticulation somewhat beyond the middle.

Subgenus Dennyus Neumann

The most important characters of the typical subgenus of *Dennyus* have been given in the key. It should be added, however, that the species composing this subgenus are remarkably alike, not only in their subgeneric characters but also in their specific characters. Hence there has been and is yet great confusion in regard to the synonymy of the species. Neither Harrison nor Ferris was able entirely to clear up the synonymy of the species. It had been the hope of the present writer to make a definite contribution along this line, but the inability to get hold of the types has prevented. All of the lots of specimens of the subgenus *Dennyus* examined by the writer belong to three species, of which two are new. They are separated by the following key.

KEY TO SPECIES OF SUBGENUS DENNYUS DESCRIBED IN THIS PAPER

1. Setae on central hyaline area of prosternal plate short and spikelike and about 10 in number ..... D. richmondi, new species.
   Setae on central hyaline area of prosternal plate long, setiform and much less than 10 in number ..... 2.

2. Prosternal plate with more than 5 setae; lateral pronotal processes each with 2 setae and 2 spines ..... D. australis, new species.
Prosternal plate with less than 5 setae; lateral pronotal lobes each with 1 and 2 spines ..... D. dubius (Kellogg.)

DENNYUS (DENNYUS) RICHMONDI, new species

Head broader than long; forehead distinctly angulate laterally; temples expanded laterally at the anterior angles, thus lacking their typical shape. Eyes of a pair subequal, but slightly fused and poorly pigmented. Posterior subapical seta of temporal lobe much longer than the other cephalic setae and flanked on each side by a minute marginal spine.

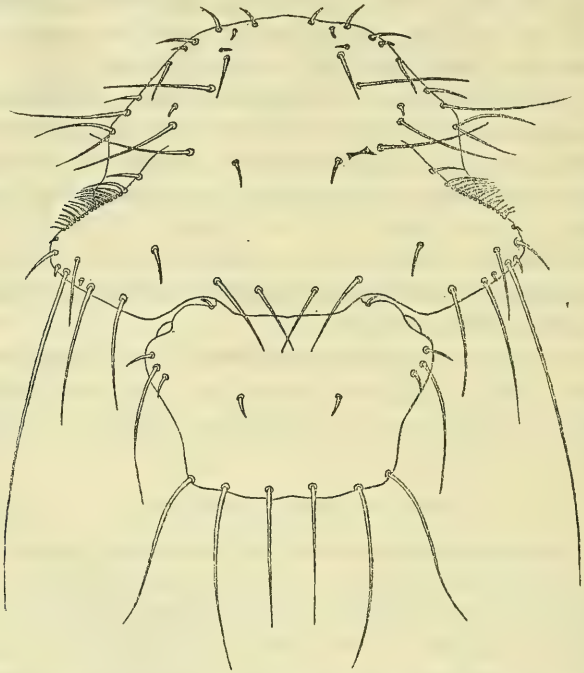

FIGURE 1.—DENNYUS (DENNYUS) RICHMONDI, NEW SPECIES. DORSAL VIEW OF HEAD AND PROTHORAX, ×60. (Drawn by Miss Heurich)

Prothorax broader than long, with broad lateral pronotal lobes, each bearing a single long seta and two short spinelike ones. Discal setae of pronotum very short, spinelike; marginal setae equally spaced, the middle pair being slightly the longest. Prosternal plate with very broad chitinous margins. It has a single pair of long setae and about a dozen short spinelike ones.

Mesthorax distinct, separated from the metathorax by a definite dorsal suture, more than twice as broad as long. It is outwardly rounded behind, has an enormously thickened anterior wall and no dorsal setae.

Metathorax considerably larger than the mesothorax, over twice as broad as long and with greatly thickened lateral walls. It bears three pairs of short dorsal discal setæ and a row of mixed long and short ones on the posterior margin.

Abdomen almost twice as long as broad and somewhat swollen in the middle. Basal plate of male genital armature decidedly rod-like and extending forward into the third abdominal segment; parameres slender, gently incurved and surpassing the endomeres by almost half their length; endomeres free, more or less spatulate, not united, even at their bases.

Legs short for the genus with the pseudoarticulations of the tibiæ very evident; first femora broader than long; patches of setæ on last femora extending along over one-half the length of the segment.

Length of male, 1.80 mm.; width, 0.70 mm.

Type host.—Richmond's swift, *Chaetura richmondi.*

Type (*cotype*).—Cat. No. 42760, U.S.N.M.

Described from two males; one from type host, Eden, Nicaragua, 1922 (W. Huber), the other, an evident straggler, from boat-billed flycatcher, *Megarynchus pitangua*, Eden, Nicaragua, 1922 (W. Huber). This species is very distinct in the characters of the prosternal plate, the setae on the temporal lobes and in having much shorter femora than most of the others. It is named in honor of Dr. C. W. Richmond, of the United States National Museum, for whom the bird host was named a number of years ago.

DENNYUS (DENNYUS) AUSTRALIS, new species

Head of typical shape for the subgenus; forehead strongly arched in front and with slight lateral angles; temples quadrangular, with posterior angles rounded. Eyes with fused double corneas but with a single pigment spot. The two inner pairs of the marginal setæ of temporal lobes subequal and very long, being equal in length to any of the setæ of the head. Occipital setæ equally spaced and over two-thirds as long as the prothorax.

Prothorax broader than long; lateral pronotal lobes pronounced, each bearing two long setae and two short spines. Prosternal plate with very heavy lateral borders, and bearing about half a dozen moderate setae in addition to the anterior pair of minute setae.

Mesothorax over twice as broad as long, separated from metathorax by a distinct dorsal suture. Its lateral margins are slightly rounded outwardly and the posterior border is subangulate at the median line. The mesothorax is covered above in part by the backwardly projecting pronotum and bears no dorsal setae.

Metathorax over twice as broad as long, with almost straight divergent sides; dorsally it bears three pairs of small, short, discal setae and a posterior marginal row of long setae.

Abdomen about twice as long as wide; pleural spines not stout but somewhat setalike; last tergite of female, which forms the posterior margin of the body, with a fringe of very closely set, subequal setae.

Legs rather long for the genus; first pair of femora longer than broad; last femora considerably longer than the middle pair, and each patch of setae extending for over two-thirds the length of the segment.

Length of female, 2.75 mm.; width, 1.30 mm.

Type host.—A swift, *Micropus andecola.*

Type (*holotype*).—Cat. No. 42761, U.S.N.M.

FIGURE 2.—DENNYUS (DENNYUS) AUSTRALIS, NEW SPECIES. DORSAL VIEW OF HEAD AND PROTHORAX, ×60. (Drawn by Dr. E. A. Chapin)

Described from a single female taken from the type host at Potrerillos, Mendoza, Argentina, March 18, 1921 (A. W. No. 6245), by Dr. A. Wetmore. This species is closely related to *D. dubius* Kellogg, but has the head differently shaped and has a different prosternal plate.

DENNYUS (DENNYUS) DUBIUS (Kellogg)

Head of typical shape for the genus but varying much in regard to the development of the lateral angles on the forehead. These may be wanting, as shown in Figure 3, or they may be as well developed as in *D. australis.* Posterior angles of temples pronounced; eyes with double, and usually partly fused, corneas; occipital setae about two-thirds as long as prothorax.

Prothorax typical in shape, with well-developed lateral pronotal lobes, each bearing a long seta and two spines; middle pair of pos-

terior marginal setae the longest. Prosternal plate with very long setae.

Mesothorax about three times as broad as long but with a distinct dorsal suture separating it from the metathorax. Its sides are very strongly divergent, posterior margin outwardly rounded, and it bears no setae above.

Metathorax over twice as broad as long, its straight, divergent lateral borders being heavily chitinized.

Abdomen about twice as long as broad; setae forming pleural tufts very long and somewhat flagellate; marginal setae of last tergite of female much longer toward the sides than in the middle. Basal plate of male genital armature distinctly platelike, though narrow

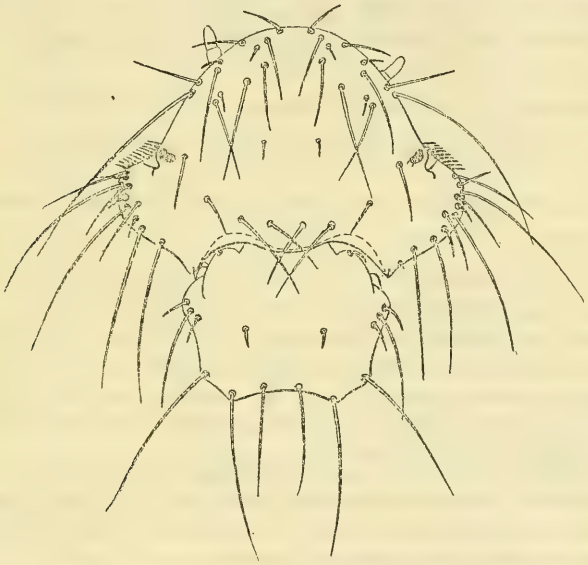

FIGURE 3.—DENNYUS (DENNYUS) DUBIUS (KELLOGG). DORSAL VIEW OF HEAD AND PROTHORAX, ×60. (Drawn by Dr. E. A. Chapin)

and with incurved lateral margins; parameres incurved toward their distal ends so that these touch each other; endomeres separate and about two-thirds as long as parameres.

Legs typical; anterior femora as broad as long; patch of setae on each posterior femur extending for about two-thirds the length of the segment; pseudosegmentation of each tibia very evident.

Length of female, 2.40 mm.; width, 1.00 mm.; length of male, 2.20 mm.; width, 0.80 mm.

Type host.—Chimney swift, *Chaetura pelagica.*

Types.—In Stanford University Collection.

Description based upon many adult specimens chiefly from the type host. They have the following data: From *Chaetura pelagica* Thomasville, Ga., October 7, 1927 (1 male, 2 females); from nest of

the same host, Maywood, Va., July 22, 1926 (1 female); from same host, Four-mile Run, northern Virginia, August 17, 1913 (1 male, 1 female); same host, District of Columbia, August 20, 1895 (4 females); same host, Arendtville, Pa., May 20, 1923 (1 female); same host, Columbus, Ohio, June 5, 1899 (3 nymphs); from *Aeronautes melanoleucus*, San Bernardino County, Calif., November 30, 1916 (4 females); from *Chaetura richmondi*, Eden, Nicaragua, 1922 (1 female); from *Falco rusticolus*, Commander Islands, February 28, 1883 (1 female) (straggler). The original description of this species was based on immature specimens and, according to Ferris (1916), it "is very likely a synonym of either *D. burmeisteri* or *D. tibialis*." Ferris examined a cotype of *D. bruneri* (Carriker) and said that it "is almost certainly a synonym of *D. dubius*." The present writer agrees with Professor Ferris in regarding *bruneri* as a synonym of *dubius*.

This species which apparently has the chimney swift for its favored host, also is found on the other swifts. It is variable to a considerable degree in the adult state and of course the characters of the immature individuals are decidedly different from those of the adults.

ANNOTATED LIST OF SPECIES OF THE SUBGENUS DENNYUS WITH THEIR TYPE HOSTS

1. *D. bruneri* CARRIKER (1903). Univ. Neb. Stud., vol. 3, p. 55.
   Type host: Aeronautes melanoleucus (= *D. dubius* Kellogg.)
2. *D. burmeisteri* DENNY (1842). Anop. Brit., p. 230, pl. 22, fig. 5.
   Type host: Micropus apus. (= *D. truncatus* Olfers.)
3. *D. distinctus* FERRIS (1916). Can. Ent., vol. 48, p. 310, figs. 10*a*, 15.
   Type host: Collocallia species.
4. *D. dubius* KELLOGG (1896). New Mallophaga, vol. 2, p. 540, pl. 73, fig. 6.
   Type host: Chaetura pelagica. (May = *D. truncatus* Olfers.)
5. *D. femuralis* KISTIAKOWSKY (1926). Zool. Anz., vol. 68, p. 10, fig. 1.
   Type host: Hirundo rustica gutturalis.
6. *D. major* UCHIDA (1923). Tokyo Journ. Col. Agr., vol. 9, No. 1, p. 32, figs. 10–11.
   Type host: Hirundapus caudacutus caudacutus. (Described as type species of *Takamatsuia.*)
7. *D. meridionalis* CARRIKER (1903). Univ. Neb. Stud., vol. 3, p. 178.
   Type host: Chaetura griseiventris.
8. *D. minor* KELLOGG and PAINE (1914). Rec. Ind. Mus., vol. 10, p. 242.
   Type host: Micropus affinis.
9. *D. piageti* KISTIAKOWSKY (1926). Zool. Anz., vol. 68, p. 11, fig. 2.
   Type hosts: Hypotriorchis subbuteo and *Riparia riparia.*
10. *D. pulicaris* NITZSCH (1861). Zeit. f. ges. Nat., vol. 18, p. 304.
    Type host: Micropus apus. (= *D. truncatus* Olfers.)
11. *D. tibialis* PIAGET (1880). Pédiculines, p. 576, pl. 68, fig. 5.
    Type host: Micropus apus. (= *D. truncatus* Olfers.)
12. *D. tibialis* CARRIKER (1902) (not Piaget, 1880). Journ. New York Ent. Soc., vol. 10, p. 225, pl. 22, figs. 4, 5.
    Type host: Aeronautes melanoleucus. (=*D. dubius* Kellogg.)
13. *D. truncatus* OLFERS (1816). De vegetativis, etc., p. 91.
    Type host: Macropus apus. (Type species of genus.)

Subgenus CTENODENNYUS, new subgenus

In addition to the characters of the subgenus *Ctenodennyus* given in the key to the subgenera of *Dennyus*, some others of minor importance should be added. The head is broader than in the typical subgenus, and the posterior angles of the temples are much reduced. The inflation of the anterior femora is so pronounced that these segments are much broader than long, also the second and third femora are inflated along the dorso-distal aspect, the expansion extending beyond the tibio-femoral articulation as a cusp.

Type species.—C. spiniger, new species.

Only the type species included. It was taken from a swift, *Cypseloides niger borealis*. This is the first record, apparently, of a species of *Dennyus* from a swift of the genus *Cypseloides*. The host was taken at Seattle, Wash. It will be interesting to see what kind of lice the South American representatives of *Cypseloides* have.

DENNYUS (CTENODENNYUS) SPINIGER, new species

Head broader than usual, with pronounced anterior angles on temporal lobes; eyes single and poorly pigmented; fringe of setae on posterior margin of ocular emargination pronounced. Above, the head bears six pairs of pigmented, peglike spines, four of which are discal and two of which are marginal on temporal lobes.

Prothorax slender, longer than broad; pronotal expansions not conspicuous, each bearing two peglike spines and a long seta. There is an additional pair of peglike setae on the pronotum near the middle of the same. Posterior marginal setae of pronotum subequal. Prosternal plate with very heavy margins and 10 peglike spines situated on the central hyaline area.

Mesothorax about twice as broad as long and separated from metathorax dorsally by an indistinct suture; dorsally it bears a minute pair of discal setae and on each shoulder three sharp, slightly curved spines.

Metathorax over twice as broad as long. Of the three pairs of dorsal discal setae the antero-lateral pair only is setalike, the other two being peglike. Of the posterior marginal setae there is a group of three (the most lateral ones) that are peglike and a pair of two sublateral peglike ones.

Abdomen about twice as long as broad; tergites bare above except for the row of spines and setae on posterior margins. Typically a spine and a seta alternate in these marginal rows, but on the first abdominal segment there are about twice as many spines as setae. The pleural plates bear spines chiefly, there being no tufts of setae. Ventrally the abdomen bears no spines; the patches of setae are situated on the sternites of fifth to seventh segments.

Legs short; first femora much broader than long, the anterior expansion of the same being quadrangular. Pseudosegmentations of tibiae faint for first pair but conspicuous for the others.

Length of female, 2.90 mm.; width, 1.05 mm.

Type host.—A swift, *Cypseloides niger borealis.*

Type (*holotype*).—Cat. No. 42762, U.S.N.M.

Described from a single female taken from the type host, Seattle, Wash., August 2, 1924, by W. L. McAtee.

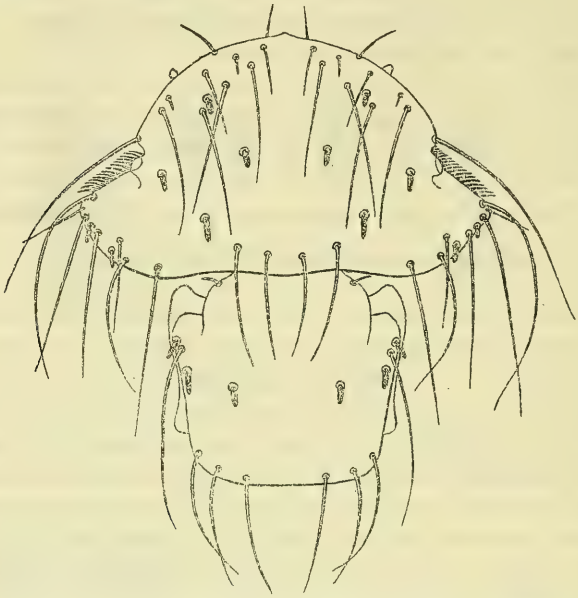

FIGURE 4.—DENNYUS (CTENODENNYUS) SPINIGER, NEW SPECIES. DORSAL VIEW OF HEAD AND PROTHORAX, ×60. (Drawn by Dr. E. A. Chapin)

Genus EUREUM Nitzsch

In addition to the characters given in the key others of minor generic importance should be added: Instead of there being only six posterior marginal setae on the pronotum there are twelve. The mesothorax is greatly reduced, so much so that but little of it is seen above; however, it is separated from the metathorax by a distinct suture. The last abdominal tergite is deeply and roundly emarginate on the median line.

Type species.—E. cimicoides Nitzsch.

The type species of the genus has as its type host the European swift, *Micropus apus.* What appears to be the same species comes from our American swift.

EUREUM CIMICOIDES Nitzsch

Head fully twice as broad as long, the forehead being broadly and evenly rounded throughout; eyes revealing their double nature in

the two almost completely amalgamated corneas; posterior angles of temples produced so as to be slightly appendiculate, anterior angles obliterated. Dorsal discal setae reduced to three or four pairs, only one of which is conspicuous.

Prothorax much enlarged, being about equal in size to the head but not so broad as the latter; pronotal lobes conspicuous, each bearing a small spine and two long setae. The prothorax is conspicuously emarginate laterally and posteriorly. On the posterior margin there is a central median tubercle. Prosternal plate as figured (fig. 7, *e*).

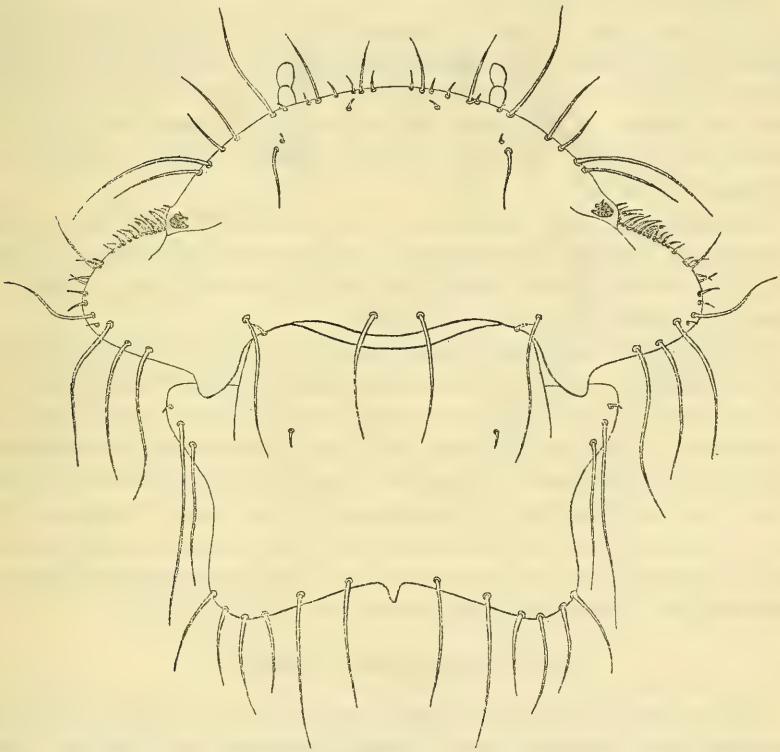

FIGURE 5.—EUREUM CIMICOIDES NITZSCH. DORSAL VIEW OF HEAD AND PROTHORAX, ×60. (Drawn by Miss Heurich)

Mesothorax very short, being about four times as broad as long; sides strongly divergent; posterior margin doubly concave; bare above and considerably overlapped by the posteriorly projecting pronotum.

Metathorax very broad, about four times as broad as long; sides almost straight and strongly divergent; antero-lateral discal setae minute, the others short spines.

Abdomen very broad, being about three-fourths as broad as long; dorsal setae rather short and hairlike, pleural tufts pronounced. Notch in last tergite extending two-thirds the way across the sclerite

and fringed with close-set hairlike setae. Ventral abdominal setae swollen at their bases and tapering to an exceedingly fine point; patches of setae on the sternites of abdominal segments five to seven.

Legs not stouter than usual for the genus; femora II and III each with a patch of spines on the anterior margin at the base; each coxa of posterior pair of legs set in a coxal cavity formed by the posterior border of the metathorax and the lateral borders of the first two abdominal sternites. Pseudosegmentation of tibiae all but wanting.

Length of female, 3.75 mm.; width, 2.10 mm.

Type host.—Micropus apus.

Described from a single female taken from the chimney swift, *Chaetura pelagica*, Columbus, Ohio, June 9, 1899, by Prof. J. S. Hine. This is the only specimen that to the knowledge of the writer has been taken of this rare species in North America. Mr. H. S. Peters has already reported (Peters, 1928) on the taking of this specimen in Ohio.

There may be some doubt about the identification of this specimen from our American chimney swift as *Eureum cimicoides*. It agrees well with the very good description and figures of Denny which were based on specimens taken in England.

If this identification is correct, how are we to explain the presence of this louse on our chimney swift, a species of a different genus from its European host and occurring in a different continent? One hypothesis is that our chimney swift has obtained the species through host transfers in recent geological times from the western *Chaetura vauxi* and the Siberian representative of the genus *Chaetura*. This is, of course, a mere speculation. It may possibly have persisted since the days of a common ancestor of *Micropus* and *Chaetura* on descendants in both of these genera.

Genus HIRUNDOECUS, new genus

This genus is a very distinct one and in fact has but little in common with *Dennyus*, as is clearly indicated in the key already given. Some other generic characters should be mentioned. The prothorax is not at all of the *Dennyus* type, but is of the type of such genera as *Menopon* and *Ancistrona*; that is, it has a very broad pronotum with an outwardly, almost evenly rounded margin. The mesothorax is distinct and separated from the metathorax by a dorsal suture, but is reduced until it is scarcely one-fifth the size of the metathorax. The genital armature is of much the same type as in *Dennyus*, but the basal plate is broader. The endomeres are united and poorly developed.

The closest affinity of *Hirundoecus* appears to be with certain species of *Menopon*, those of the type of *M. loomisii* Kellogg and

M. infrequens Kellogg, yet our knowledge of the valid generic characters of the Menoponidae is not sufficient to enable us to place this genus in its proper taxonomic position.

Type species.—Hirundoecus americanus, new species.

HIRUNDOECUS AMERICANUS, new species

Head very broad, being over twice as broad as long; ocular emarginations slight; temporal lobes reduced, rounded. Dorsal setae on or near the margins except for a centro-lateral pair.

Prothorax almost as broad and almost as large as head, with rounded lateral and posterior margins. Along its postero-lateral and lateral margins the prothorax bears sixteen long setae; at the

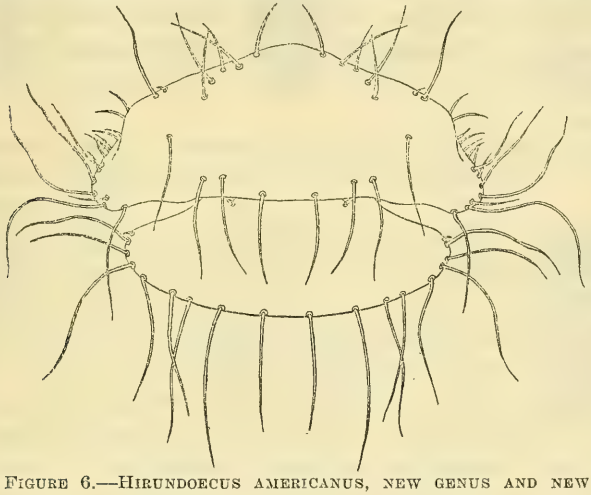

FIGURE 6.—HIRUNDOECUS AMERICANUS, NEW GENUS AND NEW SPECIES. DORSAL VIEW OF HEAD AND PROTHORAX, ×60. (Drawn by Miss Heurich)

shoulders is a pair of small spines and near the front margin another pair of small spines. Prosternal plate as figured (fig. 7, *f*).

Mesothorax inconspicuous but separate, about six to eight times as broad as long; without any setae.

Metathorax as broad as the prothorax and about two-thirds as long; of similar shape to first abdominal segment. It bears a posterior marginal row of long setae and several small lateral marginal spines.

Abdomen two-thirds as broad as long; tergites bare except for the posterior row of spines and setae, the spines of the row being lateral toward the pleurites; pleurites with conspicuous, sharp, marginal spines. Basal plate of male genital armature long and slender, reaching to about the front margin of seventh abdominal segment; parameres long, almost equal in length to the basal plate.

curved first inward then outward at their tips; parameres but slightly developed and united.

Legs short and somewhat stout, the first pair being but slightly shorter than the second, and the second but slightly shorter than the third; first segment of tarsi poorly developed; claws moderate.

Length of male, 1.70 mm.; width, 0.80 mm.

Length of female, 1.90 mm.; width, 1.15 mm.

Type host.—Progne subis subis.

Type (*cotype*).—Cat. No. 42763, U.S.N.M.

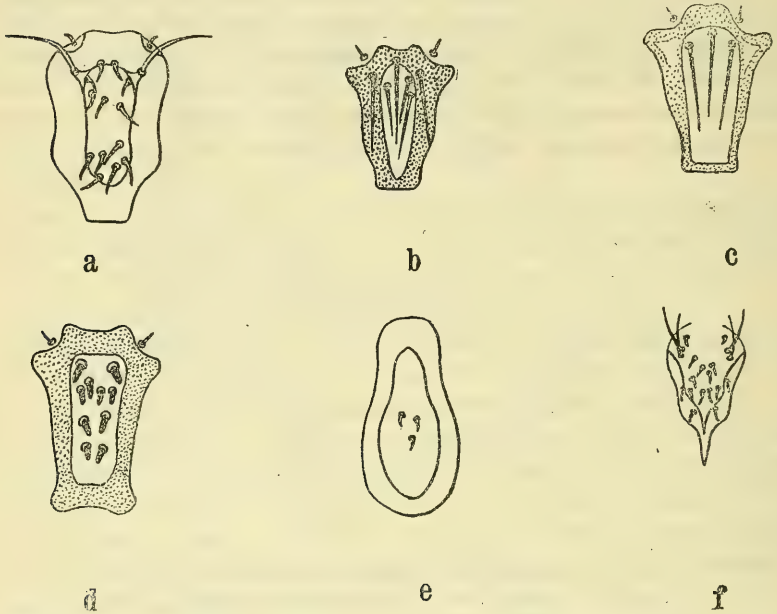

FIGURE 7.—THE PROSTERNAL PLATES OF; *a*, D. (DENNYUS) RICHMONDI, NEW SPECIES; *b*, D. (DENNYUS) AUSTRALIS, NEW SPECIES; *c*, D. (DENNYUS) DUBIUS (KELLOGG); *d*, D. (CTENODENNYUS) SPINIGER, NEW SPECIES; *e*, EUREUM CIMICOIDES (NITZSCH); *f*, HIRUNDOECUS AMERICANUS, NEW SPECIES. (All enlarged 80 times, and drawn by Miss Heurich and Dr. E. A. Chapin)

Described form a male and a female taken from purple martin, *Progne subis subis*, Reserve, New Mexico, May 25, 1927, H. H. Kimball. A very distinct species.

THE SYSTEMATIC POSITION OF THE GENERA DENNYUS AND EUREUM

In view of the fact that the closely related genera *Dennyus* and *Eureum* are well defined and show an abundance of evidence of constituting a natural group confined to swifts, interest attaches to their zoological or systematic position in the suborder *Amblycera*, a suborder which is the more primitive of the two making up the order Mallophaga.

In certain repects *Dennyus* and *Eureum* are primitive or generalized, having the primitive characters as follows:

1. A well developed and clearly separated mesothorax.
2. A double pair of eyes.
3. Simple and generalized tarsi, devoid of important reductions or modifications.
4. A simple and generalized type of male genital armature.

On the other hand, the genus is characterized by a much larger number of specialized characters, among them being:

1. Last two segments of antennae formed into a subglobose structure.
2. Antennae situated in very deep fossae.
3. Temples of head modified into a shape different from practically all other genera of Mallophaga and characteristic of the genus.
4. Anterior femora greatly modified by inflation.
5. Prothorax specialized in having lateral, expanded, spiniferous lobes.
6. Prosternal plate abnormally developed and overchitinized.
7. Posterior femora and some of abdominal sternites provided with patches of setae.
8. Pleurites of abdomen bear marginal spines.
9. Tibiae show marked evidence of incipient segmentation by the development of a transverse suture.

All points considered, *Dennyus* and *Eureum* should be regarded in the same light as many other mallophagan genera. They evidently are ancient genera with many highly specialized and correlated characters, yet at the same time they possess a few very primitive ones. They in all probability represent a complex that has had a paralleled phylogeny with their hosts, the swifts.

THE SYTEMATIC POSITION OF THE GENUS HIRUNDOECUS, NEW GENUS

Let us now take these same 13 characters that have been considered in regard to *Dennyus* and *Eureum* and observe them in *Hirundoecus*. We have:

1. Mesothorax greatly reduced, inconspicuous, yet showing a dorsal suture between it and metathorax.
2. Eyes wanting.
3. Same as in *Dennyus* and *Eureum*.
4. Genital armature showing slight modification from generalized type.

The adaptive or specialized characters follow:

1. Same as in *Dennyus* and *Eureum*.
2. Fossae even deeper than in *Dennyus* and *Eureum*.
3. Temples considerably modified from usual shape.
4. Anterior femora similar to others.

5. Prothorax specialized almost entirely by its great breadth.

6. Same as in *Dennyus* and *Eureum*.

7. No patches of setae on posterior femora or on some of abdominal sternites.

8. Same as in *Dennyus* and *Eureum*.

9. No evidence of any incipient segmentation of the tibia.

Hirundoecus thus has two only of the four important primitive characters listed for *Dennyus* and *Eureum*. Of the nine specialized characters of *Dennyus* and *Eureum*, *Hirundoecus* has three of the same kind. Of the remaining six specialized characters, *Hirundoecus* is without three, it has two that are less specialized or developed than in *Dennyus* and *Eureum* and one that is more specialized.

Hirundoecus, therefore, is not to be regarded as of such an ancient type as *Dennyus* or *Eureum*, also it is not a genus as highly specialized. It is decidedly more in line with the prevailing types of Menoponidae than is *Dennyus* and *Eureum* notwithstanding the unusual shape of the body.

BEARING ON HOST PHYLOGENY

Our data are not sufficient to enable us to present much that is of value bearing on host phylogeny. It appears, however, that the Amblycerous Mallophaga of swifts and swallows instead of being closely related and belonging to the same genera should be placed, on morphological grounds alone, into widely separated genera.

The swift-infesting genera *Dennyus* Neumann and *Eureum* Nitzsch are not related to the hummingbird-infesting genus *Trochiloecetes* Paine and Mann. *Trochiloecetes* belongs to a different family, the Ricinidae, which should include lice almost, if not entirely, from passerines and hummingbirds.

A study of the Ischnoceran Mallophaga of swallows may throw some light on the problem of host and parasite phylogeny.

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